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QUALITY AND RESERVES OF STRIPPABLE COAL, SELECTED DEPOSITS, SOUTHEASTERN MONTANA

Robert E. Matson, et al

Montana Bureau of Mines and Geology

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Proximate analyses, forms of sulfur, calorific values, and major ash constituents of the coal samples are tabulated.

The report includes the results of Montana Bureau of Mines and Geology projects in cooperation with Burlington Northern, Inc., and with the Office of Fuel Resources, Environmental Protection Agency, supported by special appropriations by the Legislature.

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QUALITY AND RESERVES OF STRIPPABLE COAL, SELECTED DEPOSITS, SOUTHEASTERN MONTANA

by

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Analytical Data by

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MONTANA COLLEGE OF MINERAL SCIENCE AND TECHNOLOGY
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ABSTRACT

Quality and quantity of strippable subbituminous and lignite coal in 32 deposits are described, and coal distribution is shown on 46 plates. All of the coal is classified as low in sulfur except the Sweeney Creek-Snyder Creek coal deposit; its reported sulfur content exceeds 1% in four core samples. Total strippable reserves are 32 billion tons on 770,000 acres.

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INTRODUCTION

BACKGROUND FOR STUDY

In recent years, concern about the environment has resulted in legislative restrictions on SO_2 emissions from coal-fired power plants. The power companies are therefore seeking low-sulfur fuel to help them to comply with these regulations.

In the late sixties, the National Air Pollution Control Administration, U.S. Department of Health, Education,

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Dr. Albert P. Talboys, in 1969 the acting Chief of the Office of Fuel Resources, National Air Pollution Control Administration, U.S. Department of Health, Education, and Welfare (now the Air Pollution Control Office of the Environmental Protection Agency), encouraged and supported the major project. The assistance and cooperation of Dr. S.L. Groff, State Geologist and Director of the Montana Bureau of Mines and Geology (then Chief of the Ground Water and Mineral Fuels Division of the Montana Bureau of Mines and Geology), in obtaining this grant is also appreciated. Charles D. Yaffe, former Director, Don R. Goodwin, former Acting Director, and Robert L. Ajax, Chief of the Division of Control Agency Development, facilitated administration of this project. Russel C. Flegal and Robert M. Jimeson, Physical Science Administrators, aided in the completion of this project. Frederick W. Lawrence, Chief of the Washington Liaison Staff of the Environmental Protection Agency, provided support for the project. Henry C. Steed, Chief of the Grants Operation Branch of the Environmental Protection Agency, expedited fourth year project funds.

Several Federal agencies cooperated with the Bureau on this project. Elmer M. Schell, Area Geologist, Northern Rocky Mountain area, Mineral Classification Branch of the U.S. Geological Survey in Casper, Wyoming, took an active interest in the field program as it was executed, and he reviewed the report previous to publication. The Bureau of Land Management provided special use permits for drilling test holes on federally owned coal lands, and the Forest Service also provided such permits on the Custer National Forest within the mapped area. Both the Bureau of Land Management and the U.S. Forest Service also provided colored photos and high altitude infrared photographs where available. The Pittsburgh Energy Research Center, under Forest E. Walker and Roy S. Abernathy, provided control samples and advice on analytical techniques.

George Nugent and John R. Ratchye of Rosebud Coal Sales Company provided data useful in evaluation of the Decker and Deer Creek coal deposits. Graham R. Curtis of Gulf Mineral Resources helped to name and correlate the coal beds and provided data on the Kirby coal deposit. Ernest Thurlow, Barney Binon, Loren Williams, and Peter Mattson of Burlington Northern, Inc., provided data for this report. Loren Williams also compiled several of the maps in this report from field data.

Over the four-year period, many student assistants, graduate assistants, and staff members of the Montana Bureau of Mines and Geology worked on various aspects of the project. Wayne Van Voast, associated with the project during 1969 and 1970, conducted the field program in the latter part of the 1969 field season and the 1970 field season. Others who worked on the project are Eldon Woods, draftsman for the Bureau, Gardar G. Dahl, Michael R. Garverich, Charles Speake, Jr., Melvin Granberg, Leonard Maki, Van Heare, and Robert Lambeth. Recognition is due the staff involved in the compilation of the final report, including Mrs. Mayme Domme, Mrs. Dorothy Ratcliff, Miss Sheila McCarthy, Mrs. Carol Blankenship, and Miss Vonnie Lavelle.

and Welfare (now the Air Pollution Control Office of the Environmental Protection Agency) recognized the need for information about the quality and quantity of low-sulfur western coal, as well as about economic conditions that would permit use of this coal to assist in combating air pollution. The Air Pollution Control Office of the Environmental Protection Agency began efforts to evaluate western coals in cooperation with agencies in various states, including the Montana Bureau of Mines and Geology, and with other Federal agencies.

The Fort Union coal region of eastern Montana was of interest because of the known reserves of low-sulfur subbituminous and lignite coal minable by surface methods. Characteristics of the topography and the thickness of the coal beds make possible the mining of large quantities of coal from relatively small, compact areas, which facilitates reclamation. Coal beds 25 to 60 feet thick are not uncommon, and in the Decker area the coal in a single bed reaches a thickness of 80 feet.

Production of coal from thick seams by strip mining is much less costly and much less hazardous for the workmen than production by underground operations. Furthermore, 90% of the coal can be recovered by surface mining, whereas only 50 to 55% can be recovered by underground methods.

Dr. Albert P. Talboys (then acting chief of the Office of Fuel Resources for the National Air Pollution Control Administration) and Dr. S.L. Groff, State Geologist and Director of the Montana Bureau of Mines and Geology, began preliminary planning early in 1969. In June 1969, the Office of Air Pollution Control of the Environmental Protection Agency approved a matching grant (Grant No. 69A-2901D), which was followed by Grant No. 70 (70B-2901D) for the second, third, and fourth years. The title of the project proposal was "Field Evaluation of Eastern Montana's Low-Sulfur, Low-Air-Pollutant Lignite and Subbituminous Coal Reserves." The funds granted by the Environmental Protection Agency were matched on an almost equal basis by the Montana Bureau of Mines and Geology.

PURPOSE AND SCOPE

The purpose of this project was to acquire qualitative and quantitative information on selected strippable deposits of subbituminous and lignite coal in southeastern Montana. That area was chosen because it was known to contain the highest-ranked coal of the Fort Union Formation, whereas most of the coal in the rest of eastern Montana ranked as lignite. Higher-ranked coal was preferred to lignite because of the expectation that much of the coal would be shipped long distances as a substitute for coal of higher sulfur content then being mined in the midwestern and eastern coal areas. Subbituminous coal has higher Btu (British thermal unit) content and less moisture than lignite. On the "as received" basis, the percentage of sulfur is about the same, but when sulfur content per million Btu is computed, the subbituminous coals have a distinct advantage. Transportation cost on a "cents per million Btu" basis also favors subbituminous coal over lignite.

Portions of Big Horn, Rosebud, Powder River, and Custer Counties were mapped to determine the strippable coal in various coal beds in the Tongue River Member of the Fort Union Formation. The report describes the results of this four-year project and also some work completed earlier.

Some of the work done prior to the start of the EPA project was done by the Montana Bureau of Mines and Geology in cooperation with Burlington Northern, Inc., beginning in 1966, when the Foster Creek coal field was evaluated (Gilmour and Williams, 1969). In 1967 and 1968, cooperative projects continued, and the Broadus, Sand Creek, Sweeney Creek-Snyder Creek, and Pine Hills coal deposits were mapped. Also during 1968, the Bureau completed most of the field work on the West Moorhead coal field (Matson, 1971), the results of which are included in the present publication. The Colstrip and Pumpkin Creek areas, previously mapped by Burlington Northern, are also included.

All available private-company drill-hole information was used in the same manner as project field data. Much information about the Decker and Kirby coal fields was provided by the Rosebud Coal Sales Company, Gulf Mineral Resources Company, and Pat McDonough. Where available, oil-well electronic logs greatly aided in the correlation of the coal beds.

LOCATION AND EXTENT OF AREA

The area described in this report includes parts of Big Horn, Rosebud, Powder River, and Custer Counties, Montana (Fig. 1). The Crow Indian Reservation and the Northern Cheyenne Indian Reservation were excluded from this study. The Sarpy Creek area was also excluded because of the large amount of coal under Indian tribal ownership.

FIELD WORK

Most of the field work for the major project was done during the summers of 1969, 1970, 1971, and 1972.

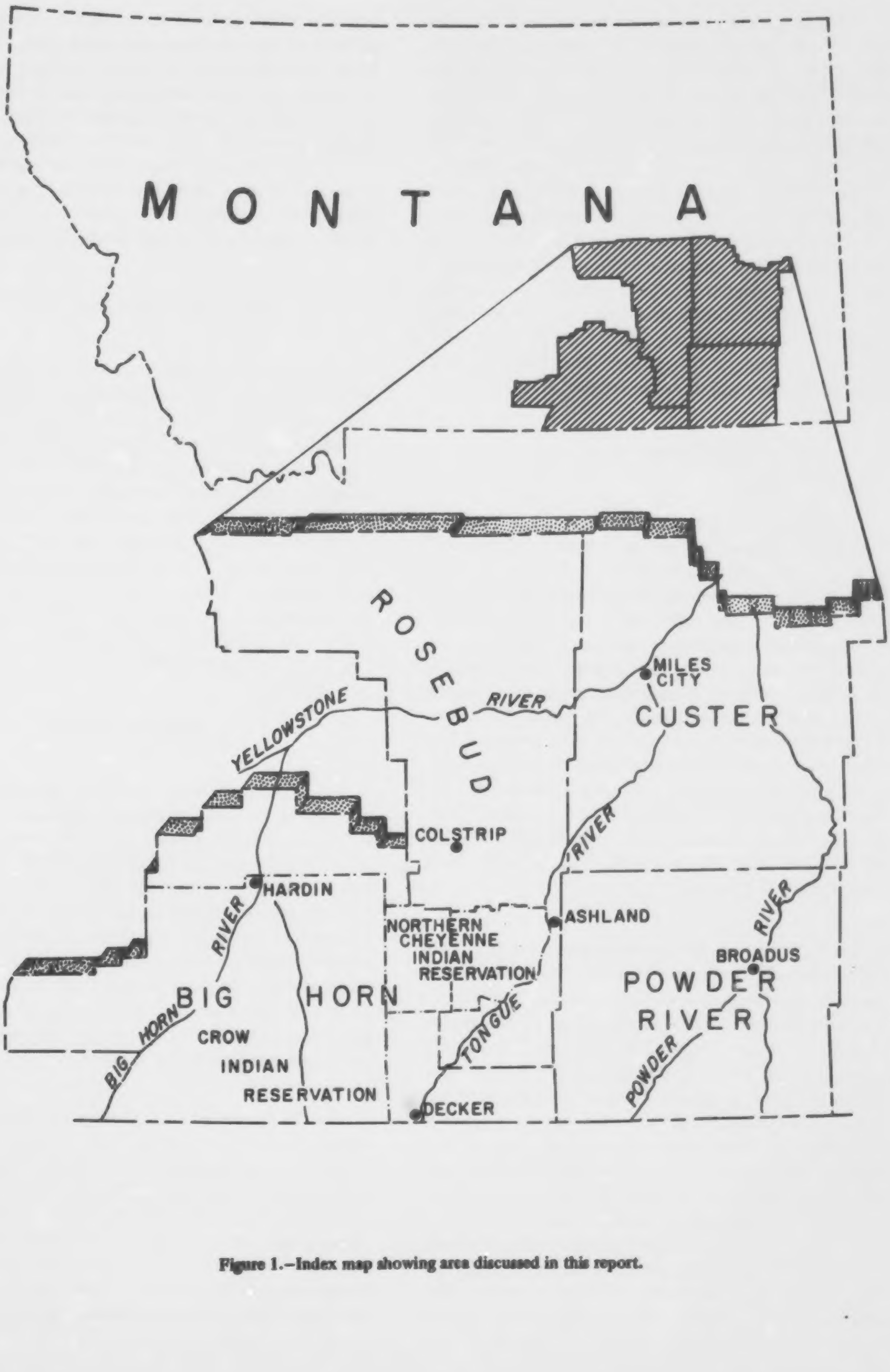
MONTANA
ROSEBUD
CUSTER
MILES CITY
YELLOWSTONE
RIVER
COLSTRIP
HARDIN
RIVER
NORTHERN CHEYENNE INDIAN RESERVATION
ASHLAND
RIVER
BROADUS
RIVER
POWDER RIVER
BIG HORN
BIG HORN RIVER
CROW INDIAN RESERVATION
TONGUE
POWDER
DECKER

Figure 1.–Index map showing area discussed in this report.

During these periods, 284 project holes were drilled and 3,272 feet of coal core obtained. Of these totals, 74 holes were drilled in 1969, and 1,317 feet of coal core obtained; 105 holes were drilled in 1970, and 1,244 feet of core obtained; 75 holes were drilled in 1971, and 692 feet of core obtained; and 10 holes were drilled in 1972, and 19 feet of core obtained. Most of the field work in 1972 consisted of surface mapping of coal outcrops, burn lines, and geologic structures in the Decker-Birney area. Small amounts of additional drilling during the late fall and winter of 1972 and early 1973 yielded information needed for completion of the overburden maps within that area. Additional drill data and core analyses useful to this project were obtained from a related project sponsored by the Mineral Classification Branch of the U.S. Geological Survey and incorporated in this report.

FIELD METHODS

The field method utilized in this project was patterned after that developed by Burlington Northern, Inc., (Carmichael, 1967) and was modified to fit varying conditions. As the method was originally developed to evaluate areas where adequate topographic maps were not available, it included the setting of temporary bench marks by leveling and the measuring of topographic configurations by altimeter surveys. Concurrently with the altimeter survey, coal outcrops, clinker, and burn lines were mapped; holes were drilled to permit measurement of the thickness of the coal and to obtain core samples for analysis of coal quality. Areas including Colstrip (Pl. 14), Pumpkin Creek (Pl. 15), Broadus (Pl. 17), Sand Creek (Pl. 28), Sweeney Creek-Snyder Creek (Pl. 22), Pine Hills (Pl. 31), and West Moorhead (Pl. 10A, B, and C) were mapped by this method.

Our modifications of the Burlington Northern field method included use of an American Paulin microbarograph for recording variations in air pressure and use of a computer for correcting altimeter elevations for changes in temperature and pressure. In other areas, topographic maps on a scale of 1:24,000 prepared by the U.S. Geological Survey Topographic Mapping Branch were available. In these areas, the principal field work consisted of determination of drill-hole locations and access, surface mapping, and drilling and coring. During the drilling operation, a driller's log showing the lithologic sequence was compiled, lithologic samples were obtained, and coal beds were cored for analysis where possible. After the completion of each drill hole, geophysical logs showing resistivity, spontaneous potential, and natural gamma were obtained, except in 1969 when the logging unit was not available. Collar altitude at each drill hole was measured by aneroid altimeter from the nearest point of known altitude and is thought to be accurate within 5 feet. Almost all project drill holes were plotted and all coal outcrops, clinker, and burn lines were mapped on 7½-minute topographic quadrangle maps where available or on aerial photos if topographic maps were not available. Cores taken during the drilling were inspected, measured, and wrapped in cellophane for delivery to the Montana Bureau of Mines and Geology analytical laboratory.

PREVIOUS GEOLOGIC WORK

All of the area included in this report had been mapped previously by the U.S. Geological Survey, and parts had been mapped by the Montana Bureau of Mines and Geology (Fig. 2). The U.S. Bureau of Mines published a report (Ayler, Smith, and Deutman, 1969) on various strippable coal deposits in Montana. A recent map of the Decker quadrangle (Law and Grazis, 1972) has been placed on open file. A two-part report entitled "Preliminary Summary Report of the Strippable Low-Sulfur Coals of Southeastern Montana" (Part 1) by Robert E. Matson and Wayne A. Van Voast and "Markets for Montana Coal" (Part 2) by Cameron Engineers, was prepared and placed on open file in 1970.

LAND OWNERSHIP

The largest coal owner in the area discussed in this report is the Federal Government. Burlington Northern, Inc., is the next-largest coal owner, as a result of the land grant of 1864 that gave the railroad all available odd-numbered sections in an area 60 miles on each side of railroad right-of-way. Within that large area, the principal coal ownership is about equally divided between the Federal Government and Burlington Northern, Inc. The State of Montana is the next-largest owner of coal in southeastern Montana, as two sections per township were granted to the state for school land. Private individuals own some coal throughout the area.

The U.S. Bureau of Land Management and U.S. Forest Service in the Decker-Birney resource study (1972), estimated the coal ownership in the Decker-Birney area (an area south of the land grant to Burlington Northern, Inc.) as 88% federal, 5% state, and 7% private. Of the federally-owned coal, 18% is within the boundaries of the Custer National Forest. The surface ownership in the Decker-Birney resource study area is 26% federal (17% within the Custer National Forest), 5% state, and 69% private.

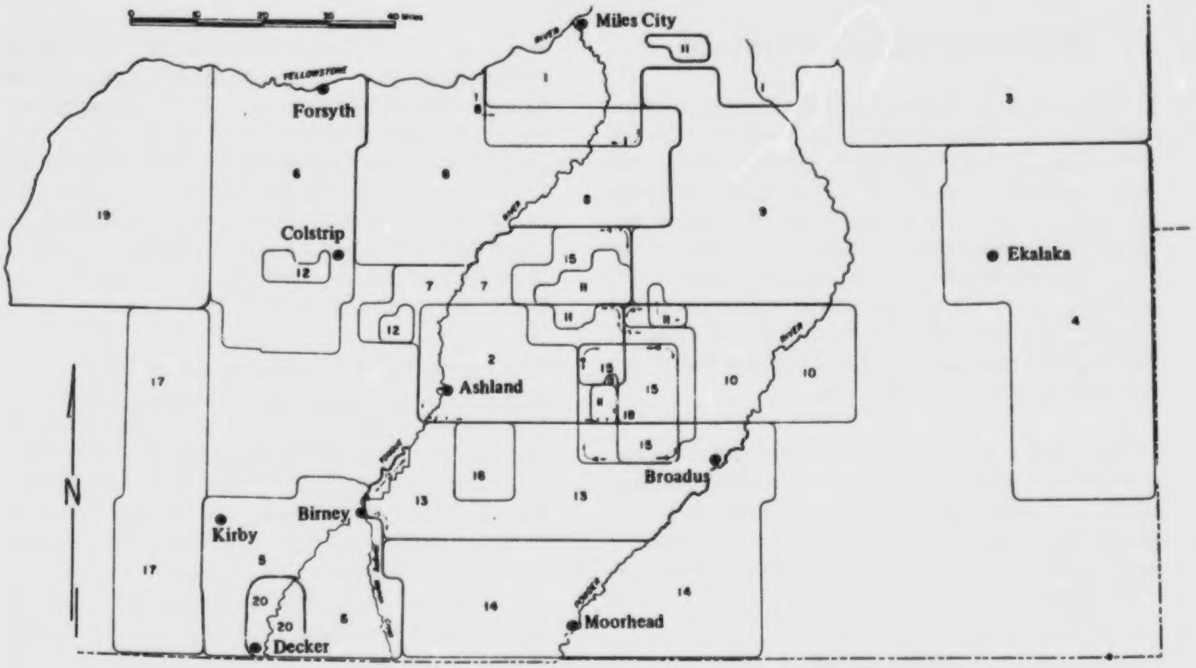

Figure 2.—Index map showing areas of previous coal studies.

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GEOGRAPHY

SURFACE FEATURES AND LAND USE

The principal surface features in the study area are the north- and northeast-trending drainages of Rosebud Creek, Tongue River, Powder River, and the larger tributaries of the Tongue River such as Hanging Woman Creek, Otter Creek, and Pumpkin Creek. All of these occupy broad valleys, which abut the edges of steep-sided ridges. The ridges are benched where resistant clinker is encountered. The tops of most of the divides are gently rolling and covered with grass. Ponderosa pine thrives on the areas of clinker and also marks the breaks where the sides steepen and become dissected.

Livestock grazing is the principal land use. Some hay is raised in meadows along the major valley bottoms, which are either irrigated or sub-irrigated, and some grains, such as wheat, oats, and barley, are cultivated. A small lumbering industry is supported in and around the Ashland area.

POPULATION

Big Horn, Rosebud, Powder River, and Custer Counties had a total population in 1970 of 23,993. As stated previously, the area discussed in this report includes only parts of these counties, and the total population within the report area would be somewhat fewer than the stated figure.

The population density of the four-county area ranges between 0.9 person per square mile in Powder River County and 3.2 persons per square mile in Custer County. Big Horn County's population density is 2.0 persons per square mile; Rosebud County's is 1.2 persons per square mile. From 1950 to 1970, Big Horn, Custer, and Powder River Counties had a small increase in population, while Rosebud County had an 8.2% decrease. The trend has already been reversed in Rosebud County as a result of the increased mining and construction activity at Colstrip.

TRANSPORTATION

The area discussed in this report is served by Burlington Northern, Inc., and by the Chicago-Milwaukee-Saint Paul Pacific Railroad, both of which pass through Forsyth along the Yellowstone River. The Milwaukee turns northwest at Forsyth and passes through Roundup to the west. The Burlington Northern follows the south side of the Yellowstone River eastward through Miles City and westward through Billings. The southern part of the area is traversed by the Burlington Northern line that extends southeastward from Huntley (a short distance east of Billings) through Sheridan and Gillette, Wyoming, and into the midwest. Burlington Northern spur lines extend south from a point west of Forsyth to Colstrip to serve the Western Energy mine and Peabody Coal Company's Big Sky mine, and south along Sarpy Creek to the Westmoreland Coal Company mine. A third spur starting a short distance east of Sheridan extends northward to Decker to serve the Decker Coal Company mine.

Interstate Highway 94 passes through Forsyth and eastward through Miles City and westward through Billings. Interstate Highway 90 extends from Billings southeastward through Sheridan, Wyoming. The central part of the area is traversed by U.S. Highway 212 from Billings, through Hardin, Crow Agency, and Broadus to Colony, Wyoming, and by U.S. Highway 312 connecting Broadus and Miles City. Highway 315 extends from a junction a few miles west of Forsyth southward to Colstrip and Lame Deer. A blacktop road extends from Acme, Wyoming, to a junction a few miles north of Decker, and another blacktop road extends from Busby south to the south boundary of the Northern Cheyenne Indian Reservation. Highway 319, at the eastern edge of the area, connects Broadus with Gillette, Wyoming. Improved roads follow the Tongue River north of Decker to the junction with Highway 312 a few miles south of Miles City. Other improved roads connect Ashland, Otter Creek, and Hanging Woman Creek to Decker. Most of the other roads are gravel or graded dirt roads that become difficult to use during periods of heavy precipitation and during the winter.

CLIMATE

The climate of Big Horn, Powder River, Rosebud, and Custer Counties is characterized by warm summers, cold winters, and pronounced variations in seasonal precipitation.

Although the annual precipitation in the area varies from less than 12 inches to 16 inches a year, depending on the location or the altitude, the greatest amount of precipitation generally occurs at the highest altitudes such as the divides between the major drainages. April, May, June, July, and August are the periods of heaviest precipitation. The largest average monthly precipitation is during June. The highest temperatures occur in July and the lowest in January; the annual mean temperature is about 45 degrees.

WATER SUPPLY

The area is drained by the northward- and northeastward-flowing Rosebud Creek, Powder River, Tongue River, and their tributaries. All major drainages enter Yellowstone River. Rosebud Creek joins it near Rosebud, which is east of Forsyth, the Tongue River enters at Miles City, and the Powder River near Terry. The principal tributaries of the Tongue River, such as Pumpkin Creek, Otter Creek, and Hanging Woman Creek, and the principal tributary of the Powder River, Mizpah Creek, are all intermittent streams. That is, at times there is no flow although water stands in ponds or pools throughout the year. The maximum discharge in the major drainages normally is during the spring runoff in May and June. Powder River has flooded during periods of heavy precipitation. Gaging stations of the U.S. Geological Survey are located on the Powder River near Moorhead and at locations south of Terry, on the Little Powder River near Broadus, and on the Tongue River below the Tongue River Dam and near Miles City. Sites for collecting data on the quality of water are at Decker and near Miles City on the Tongue River.

The Tongue River Reservoir in T. 8 and 9 S., R. 40 E., has a present storage capacity estimated at 68,000 acre-feet, and of this amount, 32,000 acre-feet is under contract for irrigation. Before water can be used for any other purpose, the approval of the Tongue River Water Users Association is needed. An engineering study of a high Tongue River dam, proposed to be constructed several miles north of the present dam, has been completed for the Montana Department of Natural Resources by Bechtel Corporation. Another site, which would provide industrial water, is the proposed Moorhead dam and reservoir a few miles north of the Montana-Wyoming border. The proposed reservoir would have a capacity of 1,150,000 acre-feet, of which approximately 92,500 acre-feet would be allocated for industrial use.

Except for Rosebud Creek, Powder River, and Tongue River, very little surface water is available in the area. Although numerous small reservoirs along the tributaries of the major drainages provide small supplies of stock water, most water for domestic, livestock, and agricultural use is obtained from wells. The alluvium along the drainages and the sandstone and coal beds in the Fort Union and Hell Creek Formations (Perry, 1935, p. 40-43) are the principal sources of ground water. Interest in the development of coal deposits has stimulated evaluation of the ground-water resources. Current work by the Montana Bureau of Mines and Geology Hydrology Division includes water-evaluation studies at the Decker mine site, in an area west of Decker at Youngs Creek in T. 9 S., R. 38 E., which is on the Crow Indian Reservation, at Western Energy mine at Colstrip, and at Westmoreland Resources mine at Sarpy Creek. The Billings office of the U.S. Geological Survey is conducting an inventory on water levels and water quality throughout the Montana portion of the Powder River Basin.

STRATIGRAPHY

FORT UNION FORMATION

The coal beds described in this report are in the Tongue River Member of the Fort Union Formation (Paleocene). The Fort Union includes three members which are, from top to bottom, the Tongue River, Lebo, and Tulloch.

The Fort Union Formation was named by Meek and Hayden (1861, p. 433) for old Fort Union, which was situated near the junction of the Missouri and Yellowstone Rivers. Subsequent field work in eastern Montana resulted in the division of the Fort Union into three members on the basis of color, lithology, topographic expression, and occurrence of coal, which were convenient criteria for division of the formation into mappable units.

Along the Yellowstone River between Rosebud and Glendive, the Fort Union Formation is divisible into its members on the basis of color alone—the dark Lebo bed contrasts with the light-colored Tulloch beds below and the light-colored Tongue River beds above—but the color differences are not in themselves distinctive in all areas of eastern Montana. Farther west, towards the source of the sediments, the dark and the lower light zones lose their identity and merge to form a greenish-gray or gray sandy sequence (Brown, 1962, p. 3). Farther southeast and east, and in western North Dakota, the lower members cannot be distinguished from one another and together are referred to as the lower member in Montana (Bryson, 1952, p. 46-52) and as the Ludlow in North Dakota (Brown, 1962, p. 6).

The base of the Fort Union was defined by Barnum Brown (1907, p. 834) as the base of the lowest coal bed above the dinosaur-containing beds of the Hell Creek Formation (late Cretaceous). Although many writers have attempted to re-define the Cretaceous-Paleocene boundary, Roland Brown (1962, p. 11) concluded after many years of study that the use of the lowest coal bed as the boundary is still valid, and where the coal is missing, the Cretaceous-Paleocene contact can be closely determined from paleontological evidence.

The greatest difference is between the Lebo and the members underlying and overlying it. The Lebo consists of dark, drab, somber beds composed of dark-gray to olive-gray shale containing altered and devitrified volcanic ash and abundant brown ferruginous concretions (Rogers and Lee, 1923, p. 36-39), whereas the Tulloch and Tongue River are both light-colored interbedded fine-grained sandstone, claystone, and siltstone and also show similarities in topographic expression. The Lebo, because of its relative softness, characteristically erodes to form long gentle slopes, whereas the Tulloch and Tongue River both form steep escarpments capped by the resistant sandstone beds that are prominent in both members. The Tongue River Member is further characterized by thick layers of reddish clinker, which have resulted from the burning of the thick coal beds.

TONGUE RIVER MEMBER

The Tongue River Member was named by Taff (1909, p. 129) in describing coal beds exposed along the valley of the Tongue River in the Sheridan coal field, Wyoming. The high divide between the Tongue River and Rosebud Creek near Brandenburg, Montana (Balster, 1971), is now regarded as the type locality, as a more nearly complete section is exposed there.

In the area described in this report, the thickness of the Tongue River Member ranges from 1,200 to 1,700 feet. In many places, the upper part has been eroded or truncated especially in the northern part of the area where the section consists of only the lower few hundred feet.

The Tongue River Member is characterized by pale-olive to yellowish-gray fine-grained sandstone, yellowish-gray claystone, interbedded claystone and sandstone, interbedded shale and claystone, thick coal beds, and carbonaceous shale. The sandstone beds and the claystone sequences occur in almost equal proportions. The sandstone beds, at various stratigraphic levels, form numerous cliffs, knobs, and pinnacles. The environment of deposition was continental, including abundant swamps that produced coal in a cyclic depositional sequence. The thick coal beds are the major interest in this report, and on the various overburden maps (Pl. 1 through Pl. 32), twenty-six individual coal beds are shown. Perhaps the most striking characteristic of the Tongue River Member is the clinker, which was formed by the burning of the underlying thick coal beds and which covers large areas. This burning has caused fusion and baking of the strata overlying the coal bed and has produced a reddish to orange multicolored zone. In some places, these clinker zones are more than 200 feet thick. The thickness of the clinker, which is roughly proportional to the thickness of the coal, is one factor utilized in exploration.

The thicker coal beds have burned near their outcrop and back from their outcrop throughout the study area. This phenomenon is attributed to spontaneous combustion, which results where thicker coal beds containing moderate to high volatile matter are exposed at the surface. There the coal can slack and become finely divided, and if it is subjected to a small increment of outside heat, such as the direct rays of the sun during the summer months, combustion begins and persists if the amount of coal is adequate to retain the heat (Rogers, 1918, p. 2). The burning of the coal beds has affected the overlying sediments to varying extent by strictly thermal metamorphism. The alteration of the sedimentary rocks produces a very striking change from the original yellowish gray to bright yellow, red, and orange.

In North Dakota, what is known in Montana as the Tongue River Member has been divided into the Sentinel Butte Member (upper) and the Tongue River Member (lower) on the basis of a color change from the typical buff or yellowish-gray below to somber gray shale beds above (Royse, 1972, p. 32).

LEBO MEMBER

The Lebo Member of the Fort Union Formation, which underlies the Tongue River Member, is 300 to 600 feet thick within the report area. Except for the basal coal bed, called the "Big Dirty", the Lebo is devoid of coal beds. The "Big Dirty" coal bed has been utilized as fuel by local ranchers, but in most places it contains so much carbonaceous shale that it produces too much ash.

The type locality of the Lebo is on Lebo Creek, north of the Crazy Mountains in central Montana, where the unit contains abundant andesitic sandstone (Stone and Calvert, 1910). In eastern Montana, as already stated, the Lebo is composed of dark-gray shale, contrasting strongly with the light-colored Tongue River above and the light-colored Tulloch below. Topographically, the Lebo forms badlands because the weathered rock does not support vegetation.

TULLOCH MEMBER

The Tulloch Member of the Fort Union Formation consists of a sequence of beds of yellow sandstone, sandy shale, carbonaceous shale, and numerous thin impure coal beds and is 275 to 500 feet thick in the study area. The top of the Tulloch is defined as the base of the "Big Dirty" coal bed, and the base is defined as the base of the coal bed above the dinosaur-containing beds of the Hell Creek Formation, of late Cretaceous age (Brown, 1907, p. 834). The type locality of the Tulloch is the valley of Tulloch Creek, Treasure County, Montana, where the unit is about 270 feet thick. Although in this area it contains ten lenticular coal beds, none of them is of adequate quantity or quality to be economically recoverable.

WASATCH FORMATION

The Wasatch Formation (Eocene) overlies the Fort Union in a few places. It is about 500 feet thick in the Powder River Basin along the Montana-Wyoming border, where it consists of varicolored claystone, sandstone, and shale. It contains a richly fossiliferous zone, as much as 30 feet thick, not more than 30 feet above the Roland coal bed (Baker, 1929, p. 34; Olive, 1957, p. 29). In some areas it is very arkosic and contains abundant conglomerate of granitic pebbles (Balster, 1971, p. 42).

The top of the Roland coal bed marks the base of the Wasatch Formation. In the Wyoming portion of the Powder River Basin, the Wasatch Formation contains commercial coal.

GEOLOGIC STRUCTURE

The area discussed in this report lies in the northern part of the Powder River Basin. The structural history has been discussed by numerous authors (McGrew, 1971; Curry, 1971, Wyoming Geological Association, 1965). The Miles City Arch-Cedar Creek Anticline separates it from the Williston Basin to the northeast; the Black Hills are adjacent on the southeast, and the Big Horn Mountains are adjacent on the west. The Powder River Basin is asymmetrical, its axis being nearer the west side.

A structure contour map (Fig. 3, from Balster, 1973) of a persistent bentonite marker below the Greenhorn Formation (upper Cretaceous) shows that the lowest point in the Montana portion of the Powder River Basin is on the Wyoming border. The structural relief from the northern part of the area to the lowest point is 2,500 feet. The structure of the Paleocene roughly conforms to this Cretaceous structure, but reversals have been noted.

COAL

COAL QUANTITY

The strippable coal resources in the deposits discussed in this report total 32,024,930,000 tons underlying 770,079 acres (Table 1). Many areas smaller than those included in this report have been omitted intentionally or in some cases inadvertently. The coal beds are fairly evenly distributed throughout the Tongue River Member, and most are remarkably free of parting. Columnar charts show the generalized relationships of the various coal beds in the northern part of the area to one another in each coal field, as well as from one coal field to another, as described in previous reports by the U.S. Geological Survey (Fig. 4). Staggered cross sections show tentative correlations of most of the major coal beds containing strippable reserves (Pl. 33, 34). Certain areas, such as the Greenleaf Creek-Miller Creek coal field (Pl. 30), the Colstrip coal field (Pl. 14), the Sweeney Creek-Snyder Creek coal field (Pl. 22), the Sand Creek coal field (Pl. 28), the Pine Hills coal field (Pl. 31), and the Knowlton coal field (Pl. 32) are not shown on the cross sections.

BURNING OF THE COAL

Large parts of the original near-surface coal reserves of the Tongue River Member have been destroyed by burning at their outcrop and beneath shallow cover. Almost everywhere, each coal bed more than 5 feet thick and of good quality has burned, and the heat has produced brightly colored clinker. Because of its appearance, this clinker is miscalled "scoria", "red shale", or "lava rock". The rocks overlying a burned coal bed have been altered, baked, and fused by thermal metamorphism (Rogers, 1918, p. 1-10).

The amount of alteration of the overlying material is roughly proportional to the original thickness and quality of the coal that has burned. Thickness of clinker can therefore be utilized in exploration as an added indication of the thickness and quality of a coal bed. A coal bed 5 to 10 feet thick will produce a clinker zone 10 to 30 feet thick, whereas a coal bed 50 feet thick may produce a clinker zone 100 to 200 feet thick.

The bright red, orange, yellow, and black clinker is used locally to surface and improve roads. Some of the fused blocks are utilized as a building material for such structures as fireplaces.

As the clinkered areas are porous and permeable, numerous springs emerge along the base of the clinker. Clinkered areas also support the growth of ponderosa pine and other vegetation along the sides of ridges.

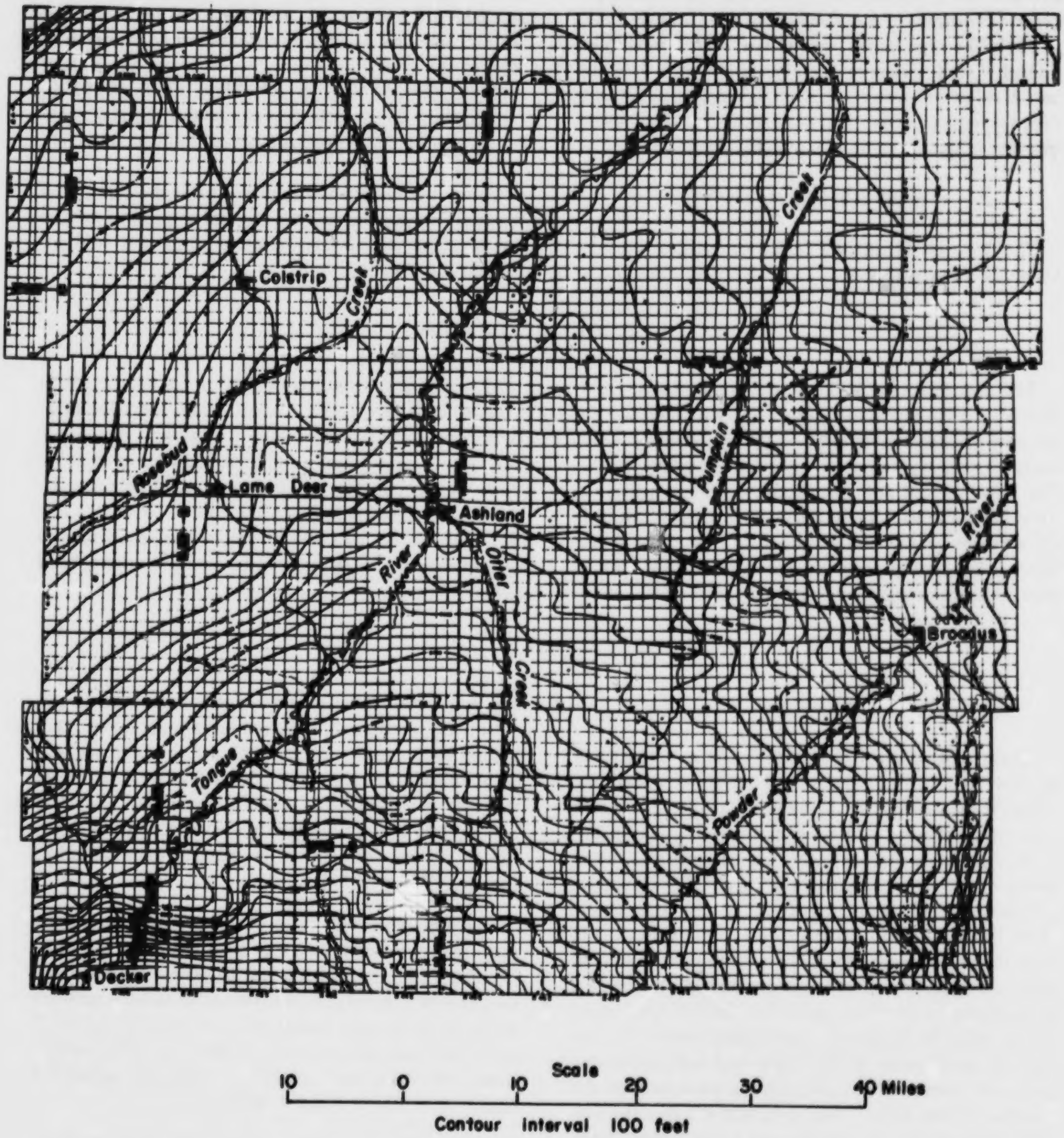
Colstrip
Creek
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Figure 3.—Structure contour map, Upper Cretaceous, Montana portion of Powder River Basin, by C.A. Balster.

Table 1.–Coal reserves, acreage, and tons per acre, selected strippable coal deposits.

Coal deposit	Plate no.	Coal bed	Reserves, million tons	Acreage	Average tons/acre
Decker	1	Anderson and Dietz 1 & 2	2,239.99	25,523	87,763
Deer Creek	2	Anderson and Dietz 1 & 2	495.65	14,214	35,397
Roland	3	Roland	218.04	12,076	18,055
Squirrel Creek	4	Roland	133.41	6,208	21,490
Kirby	5A	Anderson	216.52	5,655	38,285
		Wall	473.69	5,952	79,579
	5B	Dietz	834.35	17,516	47,630
	5C	Canyon	158.53	4,066	38,983
Canyon Creek	6	Wall	1,884.25	23,859	78,974
		Brewster-Arnold	65.86	2,067	31,859
Birney	7	Brewster-Arnold	180.55	6,969	25,905
Poker Jim Lookout	8	Anderson and Dietz	872.65	19,609	44,501
Hanging Woman Creek	9A	Anderson	1,583.29	30,547	51,830
	9B	Dietz	1,120.96	43,654	25,678
West Moorhead	10A	Anderson	883.74	19,660	44,949
	10B	Dietz	397.49	20,416	19,469
	10C	Canyon	690.19	22,547	30,611
Poker Jim Creek-O'Dell Creek	11A	Knobloch	373.29	7,890	47,311
	11B	Knobloch	564.78	7,187	78,581
Otter Creek	12	Knobloch	2,075.55	25,791	80,475
Ashland	13A	Knobloch	2,696.20	27,200	99,125
	13B	Sawyer, A and C	357.49	20,262	17,643
Colstrip	14	Rosebud	1,439.26	33,379	43,118
Pumpkin Creek	15	Sawyer	2,426.50	45,695	53,102
Foster Creek	16A	Knobloch	708.13	27,801	25,470
	16B	Terret	460.87	27,462	16,782
	16C	Flowers-Goodale	258.90	14,444	17,924
Broadus	17	Broadus	739.82	18,429	40,142
East Moorhead	18	T	525.21	15,559	33,756
Diamond Butte	19	Canyon	418.02	21,363	19,566
Goodspeed Butte	20	Cook	628.95	13,446	46,775
Fire Gulch	21	Pawnee and Cook	336.69	8,486	39,674
Sweeney Creek-Snyder Creek	22	Terret	326.33	10,921	29,880
Yager Butte	23A	Elk and Dunning	1,175.86	26,924	43,673
	23B	Cook	312.02	14,507	21,507
Threemile Buttes	24	Canyon and Ferry	225.40	13,836	16,289
Sonnette	25A	Pawnee	320.25	8,224	38,940
	25B	Cook	362.98	10,470	34,668
Home Creek Butte	26	Canyon and Ferry	217.21	4,851	44,774
Little Pumpkin Creek	27	A, Sawyer, C and D, X, and E	215.83	8,534	25,290
Sand Creek	28	Knobloch	267.34	5,952	44,915
Beaver Creek-Liscom Creek	29	Flowers-Goodale, Terret, and Knobloch	627.49	25,926	24,203
Greenleaf Creek-Miller Creek	30	Rosebud, Knobloch, and Sawyer	453.71	14,918	30,413
Pine Hills	31	Dominy	193.87	6,022	32,191
Knowlton	32A	Dominy (M & L)	747.51	19,613	38,112
	32B	Dominy (U)	120.31	4,448	27,048
			32,024.93	770,079	

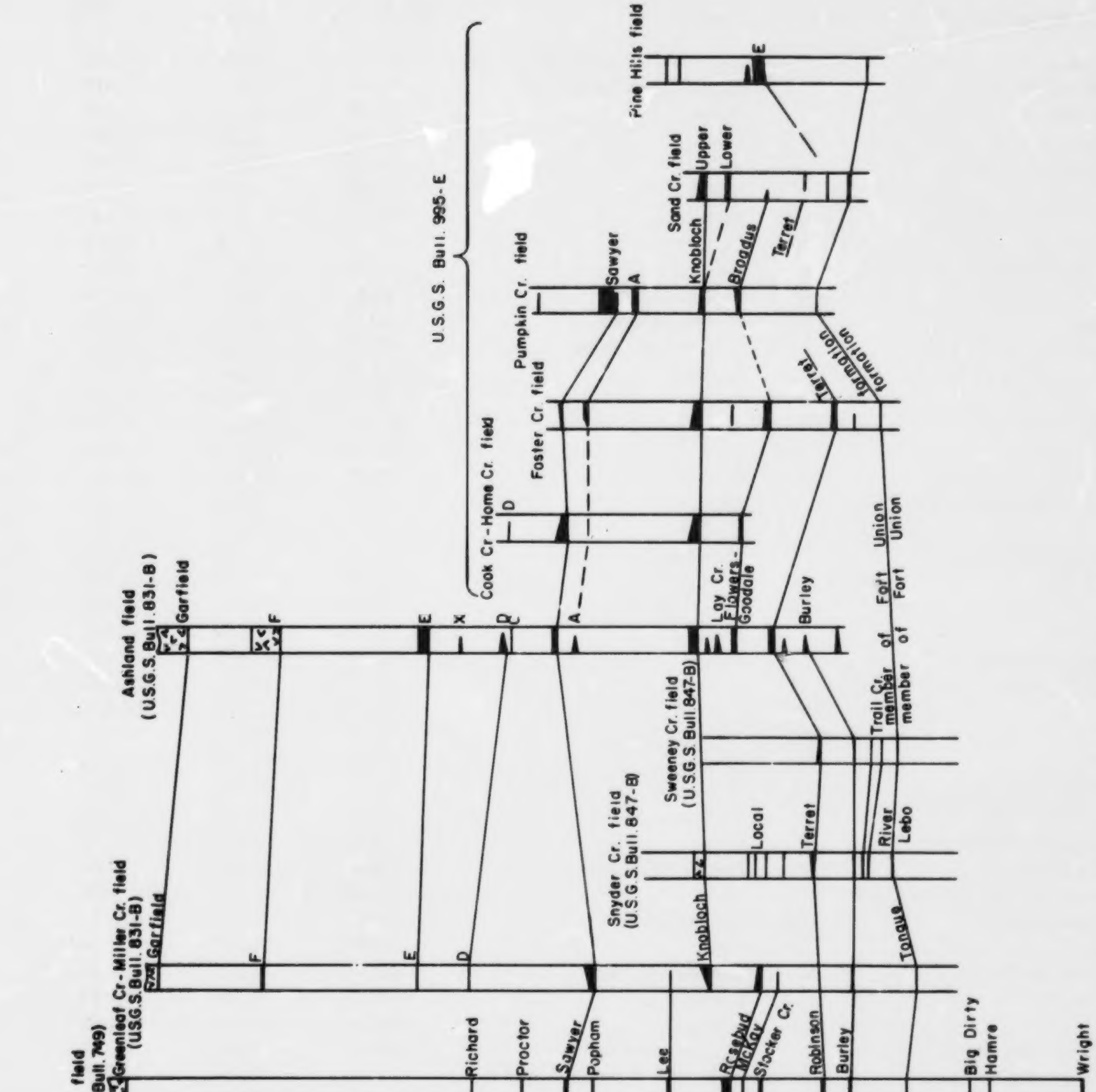
U.S.G.S. Bull. 995-E
Tullock Cr. field (U.S.G.S. Bull. 749)
R
Q
P
M
J
A
Forsyth field (U.S.G.S. Bull. 749)
Greenleaf Cr.
Richard
Proctor
Sawyer
Popham
Lee
Rosebud
McKay
Stocker Cr.
Robinson
Burley
Big Dirty
Hamre
Wright
Greenleaf Cr.-Miller Cr. field (U.S.G.S. Bull. 831-B)
Garfield
F
E
D
Knobloch
Tongue
Snyder Cr. field (U.S.G.S. Bull. 847-B)
Local
Terret
River
Lebo
Sweeney Cr. field (U.S.G.S. Bull. 847-B)
Trail Cr. member of Fort Union
member of Fort Union
Ashland field (U.S.G.S. Bull. 831-B)
Garfield
F
E
X
D
C
A
Lay Cr.
Flowers-Goodale
Burley
Cook Cr.-Home Cr. field
D
Foster Cr. field
Terret
formation
Pumpkin Cr. field
Sawyer
A
Knobloch
Broadus
Terret
formation
Sand Cr. field
Upper
Lower
Pine Hills field
E

Figure 4.--Columnar sections showing relationship of coal beds in northern part of area.

COAL QUALITY

The coal in the deposits described in this report ranks as lignite A through subbituminous A according to the specifications of the American Society for Testing and Materials (1964, p. 74). Under this classification system, coal having calorific value of 6,300 to 8,300 Btu per pound on a moist, mineral-matter-free basis is classified as lignite A; coal having a calorific value of 8,300 to 9,500 Btu per pound is classified as subbituminous C; coal having a calorific value of 9,500 to 10,500 is classified as subbituminous B; and coal having a calorific value of 10,500 to 11,500 is classified as subbituminous A.

On this project, 457 core samples were obtained and were analyzed in the Montana Bureau of Mines and Geology analytical laboratories by or under the direction of Laurence A. Wegelin. Proximate analysis, forms of sulfur, and calorific value and major ash constituents were determined in accordance with methods specified by the American Society for Testing and Materials, Laboratory Sampling and Analysis of Coal and Coke (1967) and the U.S. Bureau of Mines (1967) methods of analyzing and testing coal and coke. Constituents in the ash were determined by the standard techniques supplemented by atomic-absorption techniques, with the exceptions of sulfur, which was determined only gravimetrically, and phosphorus, which was determined only volumetrically.

Samples obtained under cooperative projects of the Montana Bureau of Mines and Geology with Burlington Northern, Inc., were analyzed by the Grand Forks Coal Research Laboratory, U.S. Bureau of Mines. Samples obtained from West Moorhead coal field in 1968 were analyzed by the Pittsburgh Coal Research Center, U.S. Bureau of Mines. Major ash constituents of these samples were analyzed by the U.S. Geological Survey Analytical Laboratory in Washington, D.C. Trace-element analyses of samples from the Decker area were made by the U.S. Geological Survey Laboratories, Denver (U.S. Geological Survey—Montana Bureau of Mines and Geology open file report, 1973).

With few exceptions, the coal is low in sulfur and has low to moderate ash content. The calorific value on the "as received" basis ranges from 6,500 Btu per pound in the Knowlton coal field (Pl. 32) to 9,850 Btu per pound in the Decker coal field (Pl. 1).

COAL BEDS

ROLAND COAL BED

The Roland coal bed marks the top of the Tongue River Member (Taff, 1909, p. 130), and the top of the Roland is defined as the contact with the Wasatch (Baker, 1929, p. 28). Although no marked difference between the Tongue River and Wasatch strata is visible in the field, on aerial photos the Wasatch has a striated appearance, particularly in the Decker area, which is not shown by the Tongue River strata. The Roland bed is 180 to 220 feet above the Smith coal bed. Strippable reserves were mapped in the Roland (Pl. 3) and Squirrel Creek (Pl. 4) coal deposits.

The Roland coal bed underlies the high divide areas in the Decker (Pl. 1), Deer Creek (Pl. 2), Hanging Woman Creek (Pl. 9), and West Moorhead (Pl. 10A, B, and C).

The Roland coal in the Roland coal deposit ranges in calorific value from 7,021 to 9,114 Btu, the sulfur content is 0.2 to 0.7%, and the ash content 3.8 to 9.7%. The Roland coal in the Squirrel Creek deposit ranges in calorific value from 6,608 to 8,286 Btu, the sulfur content is 0.2 to 0.6%, and the ash content 3.0 to 14.2%.

SMITH COAL BED

The Smith coal bed, named by Taff (1909, p. 130) for a mine of that name in the Sheridan area, was traced into the Decker, Hanging Woman Creek, and Kirby areas by Baker (1929, p. 35) and into the West Moorhead area by Bryson and Bass (1966). Although small areas containing 50 to 75 million tons of strippable coal are known in the Smith coal bed, in the Decker (Pl. 1) and Deer Creek (Pl. 2) coal deposits, they have not been included in this report. In the West Moorhead coal field and in the Hanging Woman Creek area, the Smith bed is thin and lies 110 to 150 feet above the Anderson coal bed. In the western part of the West Moorhead field, it is characterized by petrified tree stumps. The bed is as much as 12 feet thick in the Decker, Deer Creek, and Kirby areas.

Only two core samples were obtained from the Smith bed, both in the Decker coal deposit. The calorific values were 7,607 and 8,272 Btu, the sulfur content 0.6 and 1.0%, and the ash content 6.8 and 30.2%. Silica is a major ash constituent, being 38.5 and 78.3% of the total ash content.

ANDERSON COAL BED

The Anderson coal bed, named by Baker (1929, p. 35), is correlated with the Garfield bed (Matson, 1971, p. 7), named by Bass (1932, p. 55). Strippable reserves in the Anderson coal bed have been mapped in the Decker (Pl. 1), Deer Creek (Pl. 2), Kirby (Pl. 5A), Poker Jim Lookout (Pl. 8), West Moorhead (Pl. 10A), and Hanging Woman Creek (Pl. 9) coal fields.

The Anderson coal bed merges with the Dietz No. 1 bed at the Decker mine, and their combined thickness exceeds 50 feet. A short distance west of the mine, the Anderson, Dietz No. 1, and Dietz No. 2 beds are combined and have a thickness of 80 feet; still farther west, the Anderson splits from the combined Dietz No. 1 and No. 2 coal beds. In the Deer Creek coal field, the three coal beds are separate, and the Anderson bed averages 20 feet in thickness. In the Poker Jim Lookout coal field, the Anderson and Dietz are combined in the northern part of the field and form a coal bed 58 feet thick, but in the southern part, they are separate beds. In the West Moorhead coal field, the Anderson bed is 14 to 30 feet thick and lies 13 to 81 feet above the Dietz No. 1 coal bed and 120 to 200 feet above the Canyon coal bed. In Hanging Woman Creek area, the Anderson coal bed is 25 to 36 feet thick except in the southwestern part of the area, where it thins to 15 feet. It lies 50 to 100 feet above the Dietz No. 1 bed.

The Anderson coal bed in the Decker coal field has a calorific value of 8,705 to 9,850 Btu, sulfur content of 0.2 to 0.6%, and ash content of 2.9 to 6.2%. In the Deer Creek coal deposit, the calorific value is 6,594 to 9,247 Btu, the sulfur content 0.4 to 0.8%, and the ash content 3.2 to 27.3%. In the Kirby coal deposit, the calorific value is 7,277 to 8,864 Btu, the sulfur content is 0.2 to 0.7%, and the ash content 3.2 to 8.1%. In the Poker Jim Lookout coal field, the calorific value is 7,637 to 8,374 Btu, the sulfur content 0.1 to 0.9%, and the ash content 4.0 to 8.9%. In the West Moorhead coal field, the calorific value is 7,950 to 8,790 Btu, the sulfur content 0.3 to 0.4%, and the ash content 4.2 to 6.7%. In the Hanging Woman Creek coal deposit, the calorific value is 6,751 to 9,259 Btu, the sulfur content 0.1 to 0.8%, and the ash content 3.0 to 9.1%.

DIETZ COAL BEDS

The Dietz coal beds were named for the community of Dietz, about 5 miles north of Sheridan, Wyoming. Three Dietz coal beds were mapped in this locality (Taff, 1909, p. 129) and traced northward into the Decker area (Baker, 1919, p. 35). The uppermost Dietz, or Dietz No. 1, is correlated with the Anderson bed in the Decker area, where the names Dietz No. 1 and No. 2 have been applied to the two coal beds underlying the Anderson, but these would probably correlate with the Dietz No. 2 and No. 3 of Taff (1909). Strippable reserves in one or more of the Dietz coal beds have been mapped in the Decker (Pl. 1), Deer Creek (Pl. 2), Kirby (Pl. 5B), Poker Jim Lookout (Pl. 8), Hanging Woman Creek (Pl. 9), and West Moorhead (Pl. 10B) coal deposits.

In the Decker area, the Dietz No. 1 and No. 2 combine with the Anderson bed and have a combined thickness of 80 feet, but at the Decker mine, only the Dietz No. 1 is combined with the Anderson to form one bed 50 feet thick. In the Deer Creek coal field, the Dietz No. 1 and No. 2 are separated by partings, and each averages 18 feet in thickness. In the Kirby coal deposit, the Dietz No. 1 and No. 2 have a combined thickness of almost 50 feet in the southwest part of the area, but split and thin to the northeast. The Dietz No. 1 bed is combined with the Anderson bed in the northern part of the Poker Jim Lookout deposit and forms a bed 58 feet thick, but splits in the southern part of the deposit. In the Hanging Woman Creek coal deposit, the Dietz No. 1 bed reaches a maximum of 18 feet in thickness, but thins to about 4 feet in the southwestern corner. In the West Moorhead deposit, the Dietz No. 1 ranges from 6 to 11 feet in thickness, but seems to be thin or absent in the northeast corner.

The Dietz coal bed in the Decker coal deposit has a calorific value of 6,019 to 9,373 Btu, sulfur content of 0.3 to 0.4%, and ash content of 2.9 to 6.3%. In the Deer Creek coal deposit, the calorific value is 9,142 to 9,561 Btu, sulfur content 0.3 to 0.7%, and ash content 2.5 to 5.2%. In the Kirby coal deposit, the calorific value is 7,467 to 9,502 Btu, sulfur content 0.3 to 2.4%, and ash content 3.2 to 14.1%. In the Hanging Woman Creek coal deposit, the calorific value is 7,722 to 8,707 Btu, sulfur content 0.2 to 0.3%, and ash content 3.7 to 9.9%. In the West Moorhead coal field, the calorific value is 7,907 to 8,080 Btu, sulfur content 0.3 to 0.7%, and ash content 3.3 to 5.2%.

CANYON COAL BED

The Canyon coal bed, named by Baker (1929, p. 36), is one of the most widespread coal beds in the report area and contains strippable coal in such widely separated areas as the West Moorhead (Pl. 10C), Kirby (Pl. 5C), Diamond Butte (Pl. 19), and Threemile Buttes (Pl. 24) coal deposits.

The Canyon coal bed in the West Moorhead coal field is 17 to 24 feet thick and lies 67 to 122 feet below the Dietz coal bed. In the Kirby coal field, the Canyon is 16 to 25 feet thick and is 180 to 230 feet above the Wall coal bed. In the Diamond Butte coal deposit, the Canyon is 7 to 16 feet thick and is about 200 feet above the Cook coal bed. In the Threemile Buttes coal deposit, the Canyon forms two benches 4 to 13 feet thick.

The Canyon coal bed in the West Moorhead coal field has a calorific value of 7,419 to 8,920 Btu, sulfur content 0.1 to 1.3%, and ash content 3.2 to 10.0%. In the Kirby coal deposit the calorific value is 8,446 to 9,113 Btu, sulfur content 0.2 to 0.3%, and ash content 3.2 to 10.7%. In the Diamond Butte coal deposit, calorific value is 7,138 to 7,897 Btu, sulfur content 0.2 to 0.5%, and ash content 3.3 to 5.2%. In the Threemile Buttes coal deposit, the calorific value is 6,646 to 7,133 Btu, sulfur content 0.4 to 2.5%, and ash content 3.8 to 8.7%.

FERRY COAL BED

The Ferry coal bed consists of discontinuous lenses underlying the high divide areas between Pumpkin Creek and tributaries of Otter Creek wert and northwest of Sonnette (Warren, 1959, p. 573). The Ferry coal bed correlates with the F coal bed in the Ashland coal field (Warren, 1959, p. 567).

Strippable reserves in the Ferry coal bed have been mapped in the Threemile Buttes (Pl. 24) and Home Creek Butte (Pl. 26) coal deposits.

The Ferry coal bed is 6 to 17 feet thick in the Threemile Buttes coal deposit and 24 feet thick in the Home Creek Butte coal deposit, where it is about 76 feet below the Canyon coal bed.

COOK COAL BED

The Cook coal bed, between the Canyon above and the Wall coal bed below, forms two benches (Warren, 1959, p. 573). Strippable coal in the Cook coal bed has been mapped in the Sonnette (Pl. 25B), Yager Butte (Pl. 23B), and Goodspeed Butte (Pl. 20) coal fields.

In the Sonnette area, the Cook bed occurs in two benches 12 to 40 feet apart. The upper bench is 10 to 14 feet thick, and the lower bench is 5 to 10 feet thick. In the Yager Butte coal deposit, the two benches are 38 to 75 feet apart; the upper bench is 0 to 19 feet thick, and the lower bench is 8 to 11 feet thick. In the Goodspeed Butte coal deposit, the parting between the two benches is 34 to 45 feet thick; the upper bench is 13 to 20 feet thick, and the lower bench is 12 to 14 feet thick.

The Cook coal bed in the Sonnette coal deposit has a calorific value of 6,547 to 7,186 Btu, sulfur content 0.7 to 1.9%, and ash content 6.5 to 13.3%. In the Yager Butte coal field, the calorific value is 5,881 to 7,703 Btu, sulfur content 0.3 to 0.7%, and ash content 3.8 to 20.7%. In the Goodspeed Butte coal deposit, the calorific value is 6,682 to 6,861 Btu, sulfur content 1.2 to 2.1%, and ash content 8.9 to 12.4%.

WALL COAL BED

The Wall coal bed, named by Baker (1929, p. 37), has large strippable reserves, which have been mapped in the Canyon Creek (Pl. 6) and Kirby (Pl. 5A) coal fields, where it is 50 to 60 feet thick. The Wall is 180 to 230 feet below the Canyon bed.

The Wall coal bed in the Canyon Creek coal deposit has a calorific value of 7,637 to 10,079 Btu, sulfur content 0.1 to 1.1%, and ash content 3.1 to 12.5%.

ELK COAL BED

The Elk coal bed, named by Warren (1959, p. 573), crops out along the steep-sided valley of Otter Creek and its tributaries. Strippable coal has been mapped in the Yager Butte coal deposit (Pl. 23A), where the bed is 10 to 21 feet thick. The Elk coal bed is 23 to 39 feet above the Dunning bed.

The Elk coal bed in the Yager Butte coal deposit has a calorific value of 7,125 to 7,943 Btu, sulfur content 0.2 to 0.5%, and ash content 3.5 to 7.4%.

PAWNEE COAL BED

The Pawnee coal bed, named by Warren (1959, p. 572), forms two benches as much as 45 feet apart in T. 4 S., R. 47 and 48 E. Warren correlated the upper bench of the Pawnee with the Dunning bed, but the name Dunning is used west of the Otter Creek-Pumpkin Creek divide. Strippable coal in the Pawnee coal bed has been mapped in the Sonnette (Pl. 25A) and Fire Gulch (Pl. 21) coal deposits. The Pawnee coal bed is 20 to 22 feet thick in much of the Sonnette coal field.

The Pawnee coal bed in the Sonnette coal field has a calorific value of 5,556 to 7,902 Btu, sulfur content 0.2 to 2.7%, and ash content 3.9 to 25.3%. In the Fire Gulch coal deposit the heating value is 7,650 Btu, sulfur content 0.2%, and ash content 6.0%.

DUNNING COAL BED

The Dunning coal bed crops out on the west side of the Otter Creek-Pumpkin Creek divide. It was named by Warren (1959, p. 572), who correlated it with the upper bench of the Pawnee in the Sonnette coal field. It is 23 to 39 feet below the Elk coal bed. Strippable coal in the Dunning coal bed is shown in the Yager Butte coal deposit (Pl. 23A) where the bed is 14 to 20 feet thick.

The Dunning coal bed in the Yager Butte coal deposit has a calorific value of 7,445 to 8,005 Btu, sulfur content 0.2 to 0.4%, and ash content 4.3 to 5.8%.

E COAL BED

The E coal bed, named by Bass (1932, p. 55), is widespread throughout the Ashland coal field. Strippable reserves were mapped in the Little Pumpkin Creek coal field where the bed is 7 feet thick. The E bed is 70 to 100 feet above the X coal bed and is correlated with the Dunning bed in the Birney-Broadus coal field to the south.

X COAL BED

The X coal bed, about 8 feet thick, occurs locally in T. 2 S., R. 46, 47, and 48 E. (Bass, 1932, p. 55) and contains strippable coal in the Little Pumpkin Creek coal field (Pl. 27). The X bed is 40 to 80 feet above the C and D coal bed and about 70 to 100 feet below the E coal bed.

C AND D COAL BEDS

The C and D coal beds, named by Bass (1932, p. 55) are two closely spaced coal beds in the Ashland coal field. Strippable reserves in the C and D coal beds occur in the Ashland coal field (Pl. 13B), and the Little Pumpkin Creek coal field (Pl. 27). The C coal bed contains abundant silicified tree stumps and log fragments and is easily identified (Bass, 1932, p. 55).

Prominent clinker in T. 2 S., R. 47 E., indicates that the thickness of the D coal bed exceeds 10 feet. The bed attains a thickness of 20 feet (Bass, 1932, p. 55) in T. 2 S., R. 45 and 46 E.

The C and D coal beds are 80 to 100 feet above the Sawyer in the Little Pumpkin Creek coal field (Pl. 27).

BREWSTER-ARNOLD COAL BED

The Brewster-Arnold coal bed, named from a mine on the Brewster-Arnold ranch in T. 6 S., R. 43 E., was correlated with the Sawyer coal bed (Baker, 1929, p. 38). Strippable reserves have been mapped in the Birney coal field (Pl. 7).

The Brewster-Arnold bed is 235 to 275 feet below the Wall coal bed and is as much as 20 feet thick. A distinct split is most pronounced west of the Tongue River.

The Brewster-Arnold coal bed in the Birney coal field has a calorific value of 7,987 to 9,417 Btu, sulfur content 0.2 to 0.7%, and ash content 3.1 to 8.2%.

T COAL BED

The T coal bed, named by Bryson and Bass (1966), has been correlated with the Cache coal bed in the Birney-Broadus coal field (Warren, 1959, p. 572). The T coal bed is 15 to 25 feet thick and about 260 feet above the Broadus coal bed.

Strippable reserves in the T coal bed have been mapped in the East Moorhead coal field (Pl. 18).

The T coal bed in the East Moorhead coal field has a calorific value of 6,867 to 7,592 Btu, sulfur content 0.3 to 1.2%, and ash content 4.2 to 13.2%.

SAWYER COAL BED

The Sawyer coal bed, named by Dobbin (1929), has been traced eastward into the Pumpkin Creek coal field (Bass, 1932, p. 52). Strippable coal in the Sawyer coal bed has been mapped in the Ashland (Pl. 13B), Little Pumpkin Creek (Pl. 27), and Pumpkin Creek (Pl. 15) coal fields.

The Sawyer coal bed is 10 to 36 feet thick and lies on or as much as 100 feet above the A coal bed In the Little Pumpkin Creek coal deposit (Pl. 27), the C and D coal beds are 80 to 100 feet above the Sawyer (Bass, 1932, p. 52).

The Sawyer coal bed in the Ashland coal deposit has calorific value of 7,740 to 7,965 Btu, sulfur content 0.3 to 0.9%, and ash content 4.0 to 6.0%. In the Pumpkin Creek coal deposit, the calorific value is 7,140 to 7,570 Btu, sulfur content 0.3 to 0.5%, and ash content 6.5 to 10.0%.

A COAL BED

The A coal bed, named by Bass (1932, p. 54), contains strippable reserves in the Little Pumpkin Creek (Pl. 27) and Pumpkin Creek (Pl. 15) coal deposits. In T. 1 and 2 S., R. 47 and 48 E., and T. 2 S., R. 48 E., it is 6 to 15 feet thick and is 40 feet below the Sawyer coal bed, but elsewhere it may merge with the Sawyer or lie as much as 100 feet below it. Carmichael (1967, p. 43) therefore thought that the A coal bed may be a lower bench of the Sawyer.

KNOBLOCH COAL BED

The Knobloch coal bed was named for the Knobloch ranch, on the east side of the Tongue River in T. 5 S., R. 43 E. (Bass, 1932, p. 52). It contains larger strippable reserves than any other mapped coal bed. These reserves are in the Poker Jim Creek-O'Dell Creek (Pl. 11A and B), Otter Creek (Pl. 12), Ashland (Pl. 13A), Beaver Creek-Liscom Creek (Pl. 29), Foster Creek (Pl. 16A), and Sand Creek (Pl. 28) coal deposits.

The Knobloch is not uniform in thickness, and it develops partings and splits (Pl. 34). Its maximum thickness in the northern part of the Otter Creek (Pl. 12) and in the Ashland coal deposit (Pl. 13A) is 66 feet. The Knobloch is 80 to 188 feet above the Flowers-Goodale and 150 to 300 feet below the Sawyer coal bed.

The Knobloch coal bed in the Poker Jim Creek-O'Dell Creek coal deposit has a calorific value of 8,380 to 9,135 Btu, sulfur content 0.1 to 0.6%, and ash content 3.7 to 6.4%. In the Otter Creek coal deposit, the calorific value is 8,011 to 9,314 Btu, sulfur content 0.1 to 0.4%, and ash content 3.0 to 10.6%. In the Ashland coal deposit, the calorific value is 7,671 to 9,070 Btu, sulfur content 0.1 to 0.5%, and ash content 3.7 to 6.8%. In the Beaver Creek-Liscom Creek coal deposit, the calorific value is 7,362 to 8,417 Btu, sulfur content 0.2 to 0.9%, and ash content 5.1 to 13.8%. In the Foster Creek coal deposit, the calorific value is 7,380 to 7,840 Btu, sulfur content 0.3 to 1.6%, and ash content 6.7 to 8.7%. In the Sand Creek coal deposit, the calorific value is 7,220 to 7,460 Btu, the sulfur content 0.3% average, and the ash content 5.1 to 8.3%.

LAY CREEK COAL BED

The Lay Creek coal bed, 2 to 6 feet thick, was named by Bass (1932, p. 54) for Lay Creek, which is in the southwestern part of T. 1 N., R. 46 E. The Lay Creek bed is 30 to 88 feet below the Knobloch coal bed (Pl. 29), is of irregular thickness and quality, and does not contain strippable reserves. In the southwest part of the Beaver Creek-Liscom Creek area (Pl. 29) drill hole SH-7075 indicates that the Lay Creek may be a split from the Knobloch, as the Knobloch splits and thins to the north.

ROSEBUD COAL BED

The Rosebud coal bed was described by Dobbin (1929, p. 27) as being about 350 feet above the base of the Tongue River Member. Mining on a large scale by Western Energy Company and Peabody Coal Company in the Colstrip area gives the Rosebud bed special significance. Strippable reserves in the Rosebud coal bed have been mapped in the Colstrip coal deposit (Pl. 14).

The Rosebud coal bed averages 25 feet in thickness in the Colstrip coal deposit. It is 18 to 61 feet above the McKay coal bed, which is 8 to 10 feet thick but which is not discussed further in this report.

The Rosebud coal bed in the Colstrip coal deposit has a calorific value of 7,810 to 9,090 Btu, sulfur content 0.5 to 1.1%, and ash content 8.1 to 12.6%.

BROADUS COAL BED

The Broadus coal bed, named for the town of Broadus (Warren, 1959, p. 570), is 100 feet above the base of the Tongue River Member; strippable reserves have been mapped in the Broadus coal deposit (Pl. 17).

The Broadus bed is 5 to 26 feet thick and was correlated by Bryson (1952, p. 75) with the Flowers-Goodale bed.

The Broadus coal bed in the Broadus coal deposit has an average calorific value of 7,438 Btu, sulfur content averages 0.3%, and ash content averages 7.2%.

FLOWERS-GOODALE COAL BED

The Flowers-Goodale coal bed, named for the Flowers mine in sec. 29 and the Goodale mine in sec. 28, T. 1 N., R. 45 E., both small wagon mines supplying coal to local ranchers (Bass, 1932, p. 53), is 9 to 12 feet thick and contains strippable reserves in the Beaver Creek-Liscom Creek coal deposit (Pl. 29). It lies 80 to 188 feet below the Knobloch and about 43 feet above the Terret coal bed.

The Flowers-Goodale coal bed in the Beaver Creek-Liscom Creek coal deposit has a calorific value of 8,102 Btu, sulfur content 1.0%, and ash content 8.1%.

TERRET COAL BED

The Terret coal bed supplied coal to and was named for the Terret ranch on Beaver Creek in T. 1 S., R. 45 E., east of the Tongue River (Bass, 1932, p. 51). The Terret coal bed is 6 to 10 feet thick and contains strippable reserves in the Beaver Creek-Liscom Creek area (Pl. 29). It is about 43 feet below the Flowers-Goodale coal bed.

The Terret coal bed in the Beaver Creek-Liscom Creek coal deposit has a calorific value of 8,170 Btu, sulfur content 0.7%, and ash content of 5.8%.

DOMINY COAL BED

The Dominy coal bed was described by Collier and Smith (1909, p. 56) and was named for the Dominy ranch, where the coal cropped out. Brown and others (1954) described two benches of the Dominy, the lower averaging 19 feet and the upper at least 6 feet in thickness. Strippable reserves in the Dominy coal bed are shown in the Pine Hills (Pl. 31) and Knowlton (Pl. 32A and B) coal deposits. Project drill holes show the upper bench to be 3 to 4 feet thick and the lower bench 17 to 20 feet thick.

The Dominy coal bed in the Knowlton coal deposit has a calorific value of 6,297 to 6,850 Btu, sulfur content 0.2 to 0.9%, and ash content 3.8 to 10.5%. In the Pine Hills coal deposit, it has a calorific value of 7,220 to 7,420 Btu, sulfur content 0.4 to 0.6%, and ash content 6.6 to 8.1%.

RESERVE ESTIMATES

The coal reserve estimates in this report are classified as "indicated" and "inferred" after Averitt (1965, p. 25). Indicated reserves are those calculated on a basis of specific measurements and partly by projection of visible data for a reasonable distance, such as 2 or 3 miles for coal beds of known continuity. Inferred reserves are those based on a broad knowledge of the geology of an area and where few measurements of the thickness of the coal bed are available. Measured reserves are limited to areas where data points for thickness of the coal are closely spaced and the quantity can be estimated accurately. Small areas of measured reserves are included on various plates but are not separately distinguished. On the other hand, areas of inferred reserves are shown on the maps.

Overburden maps were drawn for each of the strippable coal fields, and overburden thicknesses of 0 to 50, 50 to 100, 100 to 150, 150 to 200, and 200 to 250 feet were outlined on the maps. Where the coal is less than 10 feet thick, a limit of 100 feet was assigned as the maximum overburden. Other limits used were 150 feet of overburden where the coal is 10 to 25 feet thick, 200 feet of overburden where the coal is 25 to 40 feet thick, and 250 feet of overburden where the coal is more than 40 feet thick. The areas between the overburden thickness contours were then measured by a planimeter.

Coal reserves were then calculated from the average thickness of the coal as shown on the isopach maps. Measurements of the thickness of each coal bed were sufficiently numerous to assure a fair degree of accuracy in estimation of coal reserves. In calculating the coal reserves, the area as measured by planimeter was converted to acres and the result multiplied by the average coal thickness to obtain the volume of coal in acre-feet. This figure was then multiplied by 1,770 tons, the average weight of an acre-foot of subbituminous coal (Averitt, 1965, p. 21), to yield the total tonnage.

From the same planimeter data, the overburden in each thickness range was calculated in cubic yards, and the number of cubic yards of overburden per ton of coal was computed for each overburden thickness range. The acreage measured for each overburden thickness range is reported, and the tons per acre under each overburden thickness range is also reported. Variations in the tons per acre are accounted for by the irregularity in thickness of the coal.

STRIPPABLE COAL DEPOSITS

DECKER AREA

LOCATION

The Decker area is in T. 8 and 9 S., R. 38, 39, 40, 41, and 42 E., Big Horn County, Montana, approximately 20 miles northeast of Sheridan, Wyoming, by road. The maps outlining the strippable coal in the Decker area include the Decker (Pl. 1), Deer Creek (Pl. 2), Roland (Pl. 3), and the Squirrel Creek (Pl. 4) coal deposits. The area is bounded on the south by the Montana-Wyoming border, on the west by the Crow Indian Reservation boundary, and on the east by the eastern side of the divide between Hanging Woman Creek and the Tongue River. The northern boundary of the area is the limit of strippable coal as indicated by the thickness of the clinker.

FIELD WORK AND MAP PREPARATION

The field work in the Decker area was done during the summers of 1969, 1970, and 1972 under the EPA State Coal Project. In order to solve some of the problems encountered by the U.S. Geological Survey while remapping the area in 1971 and 1972, the Bureau, under a U.S. Geological Survey Mineral Classification Branch Project, drilled additional holes in 1972. Numerous drill logs were provided by the Rosebud Coal Sales Company for preparing the overburden maps in the Decker and Deer Creek areas.

The field methods utilized in evaluation of the strippable coal in the Decker, Deer Creek, Roland, and Squirrel Creek coal fields included geologic mapping on black-and-white and color photos, drilling of numerous exploration

Table 2.—Coal reserves, overburden, overburden ratio, acres, and tons/acre, Decker area.

DECKER COAL DEPOSIT–ANDERSON, DIETZ 1, and DIETZ 2 BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	87.54	78.40	0.89	1,433.6	61,063.1
50 to 100	355.35	697.73	1.96	5,689.6	62,456.1
100 to 150	668.18	1,743.36	2.60	8,467.2	78,913.9
150 to 200	716.35	1,887.62	2.63	6,553.6	109,306.3
200 to 250	412.57	1,250.34	3.03	3,379.2	122,091.0
	Total 2,239.99	Total 5,657.45	Average 2.52	Total 25,523.2	Average 87,763.5

DEER CREEK COAL DEPOSIT–ANDERSON, DIETZ 1, and DIETZ 2 BEDS

0 to 50	82.06	372.87	4.54	2,400	34,191.7
50 to 100	184.87	1,443.81	7.8	5,344	34,593.9
100 to 150	143.54	1,787.75	12.45	4,064	35,319.9
	Total 410.47	Total 3,604.43	Average 8.78	Total 11,808	Average 34,762

DEER CREEK COAL DEPOSIT–CORRAL CREEK BED

Thickness of overburden, ft.	Inferred reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	16.54	24.98	1.51	467.2	35,402.4
50 to 100	33.30	114.15	3.42	940.8	35,395.4
100 to 150	35.34	201.80	5.71	998.4	35,396.6
	Total 85.18	Total 340.93	Average 4.00	Total 2,406.4	Average 35,397.3

ROLAND COAL DEPOSIT–ROLAND BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	110.29	327.45	2.97	6,156.3	17,914.9
50 to 100	107.75	716.32	6.64	5,920.0	18,200.1
	Total 218.04	Total 1,043.77	Average 4.79	Total 12,076.3	Average 18,055.6

SQUIRREL CREEK COAL DEPOSIT–ROLAND BED

0 to 50	76.91	17.28	0.22	3,571.2	21,537.4
50 to 100	43.87	246.26	5.61	2,035.2	21,558.7
100 to 150	12.63	122.29	9.68	601.6	21,000.7
	Total 133.41	Total 385.83	Average 2.89	Total 6,208.0	Average 21,490.9

Table 3.–Proximate analysis, forms of sulfur, and heating value, Decker coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-703			Canyon	A	20.910	26.314	35.810	16.966	.730	.017	.313	.400	8081
8S 40E S26	106 to			B		33.271	45.278	21.451	.924	.022	.396	.506	10218
CCAB	116 ft.	160		C		42.357	57.643		1.176	.028	.504	.644	13008
				A	23.810	32.544	40.465	3.181	.146	.000	.051	.094	9691
	116 to			B		42.714	53.111	4.175	.191	.000	.068	.124	12720
	126 ft.	161		C		44.575	55.425		.200	.000	.070	.129	13274
				A	23.870	30.709	42.936	2.485	.377	.009	.043	.326	9541
	126 to			B		40.338	56.398	3.264	.495	.011	.056	.428	12532
	130 ft.	162		C		41.699	58.301		.512	.012	.058	.442	12955
SH-7010			Dietz	A	27.100	29.476	37.166	6.258	.431	.008	.106	.317	8769
8S 40E S15	124 to			B		40.433	50.982	8.585	.592	.011	.145	.435	12029
CBBA	134 ft.	171		C		44.230	55.770		.647	.012	.159	.476	13159
				A	24.130	29.933	42.813	3.124	.290	.009	.077	.205	9373
	134 to			B		39.453	56.429	4.117	.382	.011	.101	.270	12355
	144 ft.	172		C		41.147	58.853		.399	.012	.106	.282	12885
				A	17.310	21.218	26.663	34.809	.371	.018	.062	.291	6019
	144 to			B		25.659	32.245	42.096	.448	.021	.075	.352	7279
	152 ft.	173		C		44.313	55.687		.774	.037	.129	.608	12571
SH-7017			Anderson	A	25.790	32.350	37.606	4.255	.250	.000	.089	.161	9003
8S 38E S12	142 to			B		43.592	50.674	5.733	.337	.000	.120	.218	12132
BCDC	148 ft.	187		C		46.244	53.756		.358	.000	.127	.231	12870
				A	21.750	34.987	39.609	3.654	.188	.000	.051	.137	9436
	148 to			B		44.712	50.618	4.670	.241	.000	.066	.175	12058
	159 ft.	188		C		46.902	53.098		.252	.000	.069	.184	12649
				A	27.070	32.443	36.684	3.803	.239	.000	.080	.159	8609
	159 to			B		44.485	50.301	5.215	.328	.000	.109	.219	11805
	165 ft.	189		C		46.932	53.068		.346	.000	.115	.231	12454
SH-7018			Anderson	A	20.590	34.109	39.641	5.660	.283	.000	.034	.249	9850
9S 40E S19	215 to			B		42.953	49.919	7.128	.357	.000	.043	.314	12405
BCBA	218 ft.	190		C		46.250	53.750		.384	.000	.047	.338	13357
BMC-727			Dietz	A	25.910	31.619	39.608	2.863	.304	.008	.055	.242	9305
8S 38E S36	240 to			B		42.677	53.459	3.864	.411	.011	.074	.326	12559
CDBD	247 ft.	462		C		44.392	55.608		.427	.011	.077	.340	13064
BMC-728			Anderson	A	21.730	32.589	41.585	4.096	.246	.008	.016	.222	9768
9S 39E S25	231 to			B		41.636	53.131	5.233	.315	.010	.021	.283	12479
CDBA	232 ft.	463		C		43.935	56.065		.332	.011	.022	.299	13168
BMC-729			Anderson	A	24.040	30.836	41.243	3.881	.250	.016	.040	.194	9306
9S 39E S29	116 to			B		40.595	54.296	5.109	.329	.021	.053	.255	12252
CDBA	127 ft.	464		C		42.780	57.220		.347	.022	.056	.269	12911
				A	25.150	30.514	41.409	2.927	.231	.016	.032	.183	9212
	127 to			B		40.767	55.323	3.910	.308	.021	.042	.244	12308
	137 ft.	465		C		42.426	57.574		.321	.022	.044	.254	12808
				A	25.300	29.200	39.298	6.201	.642	.024	.079	.539	8705
	137 to			B		39.090	52.608	8.302	.859	.032	.106	.721	11654
	140 ft.	466		C		42.629	57.371		.937	.035	.116	.786	12709

[1] A, as received; B, moisture free; C, moisture and ash free.

holes, and field checking of the Rosebud Coal Sales Company drill data. Colored aerial photos of the area were lent by the Carter Oil Company.

PREVIOUS GEOLOGIC WORK

The Decker and surrounding area was described by Baker (1929) and by Ayler, Smith, and Deutman (1969), and part is shown on a U.S. Geological Survey open-file report on the Decker quadrangle (Law and Grazis, 1972). Detailed maps on an engineering scale, prepared by Decker Coal Company, were made available for reference.

LAND OWNERSHIP

Because the Decker area lies south of the land grant to Burlington Northern, Inc., the minerals under most of the area are owned by the Federal Government. In sec. 16 and 36 of each township, granted to the State of Montana for school land, the state has both the surface and the mineral rights. In the other sections, the Federal Government generally retained the coal rights, even where it deeded the surface.

SURFACE FEATURES AND LAND USE

The Tongue River Reservoir now occupies much of the broad valley of the Tongue River, which, like the broad valley of Deer Creek, is flanked by steep-sided buttes and cliffs. Numerous drainages, which trend northwest or southeast, are also bordered by steep-sided ridges and buttes. Large areas of clinker in the northern part of the area are hummocky and rolling, and the clinker zone forms vertical cliffs where cut by drainages. All tributaries of the Tongue River are intermittent streams that flow only during periods of heavy precipitation and spring runoff.

Livestock grazing is the principal use of land in the area. A small amount of hay is raised, especially on the bottomland of Tongue River and Deer Creek valleys.

GEOLOGIC STRUCTURE

The geologic structure in the Decker area is more complex than in most of the Powder River Basin; only Kirby and some parts of the Sheridan, Wyoming, area are more so. The complexity of structure is probably due to the proximity of the Big Horn uplift and the axis of the Powder River Basin. Furthermore, the Decker area is on the north flank of the Ash Creek anticline, which contains a producing oil field.

Of the several prominent structural features in the Decker coal field (Pl. 1), the most striking are the clearly defined northeast and northwest lineations consisting of fault-controlled topographic features. The northwest lineations are easily discernible, as they are followed by the North and South Fork of Monument Creek, Spring Creek, South Fork of Spring Creek, Pearson Creek, Squirrel Creek, Dry Creek, and Youngs Creek.

Except for the valley of Tongue River, the northeast-trending features are not as obvious because the faults are masked. These faults have the down-dropped block on the southeast side except in the South Fork of Spring Creek, where the upthrown block is on the southeast side of the fault. Three parallel faults in T. 9 S., R. 38, 39, and 40 E., are difficult to follow for long distances, but in some places they have an apparent displacement of as much as 200 feet.

The fault in sec. 16, T. 9 S., R. 40 E., just south of the Decker mining area, has a displacement of about 120 feet, the southeast block being down-dropped, as shown by drill hole SH-7090 on the west line of sec. 22, T. 9 S., R. 40 E. The displacement along the fault in sec. 29 and 30, T. 9 S., R. 40 E., is also approximately 120 feet, the south block being down-dropped. Strata in the Decker area dip gently southeastward 40 to 69 feet per mile except in T. 8 S., R. 39 E., where the dip is about one degree. In small areas, however, relatively steep dips are associated with faulting, especially in sec. 21, T. 9 S., R. 40 E., and in sec. 29 and 33, T. 9 S., R. 39 E.

Altitudes of the top of the Roland coal bed as determined by drilling in the Squirrel Creek coal field (Pl. 4), indicate a dip to the southwest.

Prominent structural features in the Deer Creek coal field (Pl. 2) include the northwest lineation of the drainage patterns of Deer Creek and Corral Creek. Three northeast-trending faults have been mapped in T. 9 S., R. 40 and 41 E. The down-thrown block is on the southeast except on the southernmost fault, which crosses through sec. 36, T. 9 S., R. 40 E., and the NE¼ sec. 31 and SE¼ sec. 30, T. 9 S., R. 41 E. There the down-thrown block is on the north side (Law and Grazis, 1972). Structure contours in the Deer Creek deposit indicate that the dip is to the southwest, but locally it is reversed. A small syncline in sec. 12 and 13, T. 9 S., R. 40 E., occupies an area where the distance between the Anderson and the underlying Dietz No. 1 coal bed changes abruptly. The dip in the south half of sec. 13 and extending into sec. 23, T. 9 S., R. 40 E., is about one degree. In sec. 5, 6, 7, and 8, T. 9 S., R. 41 E., the dip is relatively flat but steepens again farther northeast and again approaches one degree.

Table 4.–Trace-element analysis, Decker coal field.

(Semiquantitative 6-step spectrographic)

Drill hole and location	Depth sampled	Lab. number	Coal bed	Element, ppm.																		
				B	Ba	Be	Co	Cr	Ga	La	Mn	Mo	Nb	Ni	Sc	Sn	Sr	Ti	V	Y	Yb	Zr
BMC-723 8S 41E S30 BDCD	98 to 107 ft.	458- D160662	Dietz	1500	15000		30	70	30		500	70	20	30	30	30	7000	5000	200	30	3	200
	107 to 110 ft.	459- D160663		300	3000	7	30	70	30	70	200	70	20	30	30		3000	3000	300	50	5	150
BMC-727 8S 38E S36 CDBD	240 to 247 ft	462- D160666	Dietz	1000	5000		20	70	30		500	100		20	30	20	15000	5000	300	30	3	150
BMC-728 9S 39E S25 CDBA	231 to 232 ft.	463- D160667	Anderson	700	10000		15	50	20		500	200	20	20	20	30	7000	5000	150	30	3	200
BMC-729 9S 39E S29 CDBA	116 to 127 ft.	464- D160668	Anderson	700	7000		15	50	20		100	50	20	15	15		5000	5000	150	30	3	200
	127 to 137 ft.	465- D160669		700	10000		15	50	30		150	30		15	15		7000	3000	150	20	2	100
	137 to 140 ft.	466- D160670		300	7000	3	15	70	30	70	100	50		70	15		3000	3000	150	50	3	100

Table 5.—Trace-element analysis of coal and ash, Decker coal field.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Element, ppm in coal								Element, ppm in ash					Ash %
				As	F	Hg	Sb	Se	Te	Tl	U	Cd	Cu	Li	Pb	Zn	
BMC-723 8S 41E S30 BDCD	98 to 107 ft.	458- D160662	Dietz	2	40	.035	43.3	<.1	.1	<.2	<.2		335	27		185	3.20
	107 to 110 ft.	459- D160663		2	30	.082	13.7	.4	.1	<.2	.8	1.5	385	130	275	180	6.80
BMC-727 8S 38E S36 CDBD	240 to 247 ft.	462- D160666	Dietz	2	10	.031	4.7	<.1	<.02	<.2	<.2	<1.0	420	50	545	175	3.25
BMC-728 9S 39E S25 CDBA	231 to 232 ft.	463- D160667	Anderson	3	10	.051	19.1	<.1	.02	<.2	.4	<1.0	605	93	1660	195	4.56
BMC-729 9S 39E S29 CDBA	116 to 127 ft.	464- D160668	Anderson	1	30	.044	3.8	.2	<.02	<.2	<.2	<1.0	245	31	300	83	4.56
	127 to 137 ft.	465- D160669		1	20	.030	1.9	<.1	<.02	<.2	<.2	<1.0	180	28	195	93	3.43
	137 to 140 ft.	466- D160670		3	30	.106	1.8	.6	<.02	<.2	1.2	1.5	145	44	120	240	7.12

Table 6.–Major constituents of ash, Decker coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-703 8S 40E S26 CCAB	106 to 130 ft.	160-162	Canyon	15.6	6.7	3.4	1.4	1.4	7.0	.2	48.2	10.9	.8	95.6
SH-7010 8S 40E S15 CBBA	124 to 152 ft.	171-173	Dietz	12.4	4.5	2.0	1.9	1.8	2.2	.4	61.6	5.0	.8	92.6
SH-7017 8S 38E S12 BCDC	142 to 165 ft.	187-189	Anderson	14.7	22.3	5.3	.6	5.2	8.8	.9	29.7	10.9	1.1	99.5
SH-7018 9S 40E S19 BCBA	215 to 218 ft.	190	Anderson	16.6	13.7	3.5	.5	2.5	6.4	1.0	42.0	8.4	2.2	96.8
BMC-727 8S 38E S36 CDBD	240 to 247 ft.	462-D160666	Dietz	13.0	24.0	4.1	.6	8.7	2.3	.2	16.0	20.0		
BMC-728 9S 39E S25 CDBA	231 to 232 ft.	463-D160667	Anderson	10.0	14.0	4.2	.3	3.3	6.1	.3	37.0	12.0		
BMC-729 9S 39E S29 CDBA	116 to 127 ft.	464-D160668	Anderson	10.0	18.0	3.9	.3	9.3	1.8	.7	41.0	13.0		
	127 to 137 ft.	464-D160669		14.0	23.0	5.5	.4	12.3	1.9	4.4	14.0	16.0		
	137 to 140 ft.	464-D160670		18.0	11.0	4.1	1.3	5.7	.9	3.8	25.0	16.0		

Table 7.–Proximate analysis, forms of sulfur, and heating value, Deer Creek coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7020			Anderson	A	24.770	32.136	39.259	3.834	.777	.017	.314	.446	9247
9S 40E S35	193 to			B		42.717	52.186	5.097	1.033	.022	.417	.593	12291
DBCD	201 ft.	192		C		45.012	54.988		1.088	.023	.440	.625	12951
				A	25.550	32.912	38.311	3.228	.380	.008	.025	.347	9179
	201 to			B		44.207	51.458	4.335	.510	.011	.033	.466	12330
	207 ft.	193		C		46.210	53.790		.533	.012	.035	.487	12888
				A	19.270	21.066	32.349	27.315	.733	.026	.284	.422	6594
	207 to			B		26.094	40.070	33.835	.908	.032	.352	.523	8168
	212 ft.	194		C		39.438	60.562		1.372	.048	.533	.791	12345
SH-7022			Smith	A	27.900	31.309	33.942	6.849	.591	.090	.148	.353	8272
9S 41E S10	41 to			B		43.424	47.076	9.499	.819	.125	.205	.489	11473
ADCD	50 ft.	197		C		47.982	52.018		.905	.138	.226	.541	12678
BMC-723			Dietz	A	24.840	31.163	41.440	2.557	.300	.016	.032	.253	9561
8S 41E S30	98 to			B		41.462	55.135	3.403	.399	.021	.042	.336	12722
BDCD	107 ft.	458		C		42.922	57.078		.413	.022	.043	.348	13170
				A	25.350	31.116	38.362	5.172	.725	.008	.148	.569	9142
	107 to			B		41.682	51.390	6.928	.972	.010	.199	.763	12247
	110 ft.	459		C		44.785	55.215		1.044	.011	.213	.820	13158

[1] A, as received; B, moisture free; C, moisture and ash free.

This flexure has allowed exposure of the Anderson coal bed along the valley bottom, and its subsequent burning in sec. 3, 4, and 9, T. 9 S., R. 41 E.

In the Roland coal deposit (Pl. 3) the structure of the Roland bed is irregular. The highest altitude exceeds 4,000 feet, as shown in drill hole SH-7024 in sec. 25, T. 8 S., R. 41 E., and the lowest is 3,656 feet, as shown in drill hole SH-7021 in the southwestern part of the deposit.

COAL BEDS

In the Decker area, coal beds in the upper part of the Tongue River Member of the Fort Union Formation that contain strippable coal include the Roland, Smith, Anderson, Dietz No. 1, and Dietz No. 2 coal beds. Because reserves in the Smith coal bed are small, they are not shown on the maps. The coal beds in the Decker area have been correlated with those in the Hanging Woman Creek and Kirby areas (Pl. 33).

The major coal beds in the Decker area present an opportunity to study characteristics of coal-bed splitting and coal-field structure. Near the center of the Decker coal deposit, the Anderson, Dietz No. 1, and Dietz No. 2 coal beds are combined into a single bed approximately 80 feet thick. At the Decker mine, in sec. 16, T. 9 S., R. 40 E., east of the center of Plate 1, the Anderson and Dietz No. 1 remain combined and form a bed approximately 50 feet thick, but the Dietz No. 2 coal bed diverges from it and lies 50 feet below it. West of the center of Plate 1, the Dietz No. 1 and Dietz No. 2 remain combined, but the Anderson bed splits from it.

In the valleys of Spring Creek and South Fork of Spring Creek in T. 8 S., R. 39 E., the combined thickness of the Anderson, Dietz No. 1, and Dietz No. 2 coal averages 80 feet, but reaches a maximum of 87 feet. In the Squirrel Creek drainage, the thickness of the combination also averages about 80 feet, and in the Youngs Creek area it totals 73 feet, as shown in drill hole BMC-729, sec. 29, T. 9 S., R. 39 E. The uppermost bed in this drill hole is correlated with the Anderson bed and has a thickness of 35 feet. The underlying strata contain three coal beds 6, 20, and 12 feet thick, which are correlated with the Dietz No. 1 and Dietz No. 2 coal beds (Pl. 1, 33).

In the northeastern part of the Decker area, a prominent burn line marks the limit of unburned coal in the Anderson and Dietz No. 1 coal beds. The Dietz No. 2 coal bed, however, contains strippable reserves beneath the clinker north and northeast into T. 8 S., R. 40 E. Beneath the burn of the Anderson and Dietz No. 1, the Dietz No. 2 bed ranges from 14 to 20 feet in thickness.

Table 8.—Major constituents of ash, Deer Creek coal field.

				Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7020 9S 40E S35 DBCD	193 to 212 ft.	192-194	Anderson	22.0	3.8	4.0	3.6	1.7	2.6	.6	53.8	3.7	.8	96.6
SH-7022 9S 41E S10 ADCD	41 to 50 ft.	197	Smith	13.8	13.6	7.8	.3	6.2	1.7	.6	38.5	15.2	1.2	98.9
BMC-723 8S 41E S30 BDCD	98 to 107 ft.	458- D160662	Dietz	15.0	16.0	5.8	.4	9.6	2.4	1.7	31.0	20.0		
	107 to 110 ft.	459- D160663		22.0	7.9	4.7	.4	4.6	1.2	1.1	35.0	14.0		

Table 9.–Proximate analysis, forms of sulfur, and heating value, Roland coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-702 9S 40E S26 DDDA	53 to 63 ft.	159	Roland	A	25.920	28.204	41.953	3.924	.238	.025	.076	.136	8876
				B		38.072	56.632	5.296	.321	.034	.103	.183	11981
				C		40.201	59.799		.339	.036	.109	.194	12651
SH-7019 9S 40E S36 ADDB	74 to 83 ft.	191	Roland	A	27.160	32.291	36.778	3.771	.193	.008	.032	.153	9114
				B		44.332	50.491	5.177	.265	.011	.044	.210	12512
				C		46.752	53.248		.279	.012	.047	.221	13196
SH-7021 9S 41E S19 BAAC	54 to 60 ft.	195	Roland	A	25.750	37.072	31.400	5.779	.296	.016	.066	.214	8493
				B		49.928	42.289	7.783	.399	.022	.089	.288	11438
				C		54.142	45.858		.432	.024	.096	.312	12403
	60 to 65 ft.	196		A	24.990	29.290	36.028	9.691	.250	.017	.042	.191	8417
				B		39.048	48.031	12.920	.333	.022	.055	.255	11221
				C		44.842	55.158		.382	.025	.064	.293	12886
SH-7023 9S 41E S23 ACAB	30 to 31 ft.	198	Local	A	19.480	31.685	36.524	12.311	3.562	.156	2.302	1.103	8748
				B		39.350	45.360	15.289	4.424	.194	2.859	1.370	10864
				C		46.453	53.547		5.222	.229	3.375	1.618	12825
	166 to 170 ft.	201	Smith	A	12.960	25.604	31.243	30.193	.957	.037	.409	.511	7607
				B		29.416	35.895	34.689	1.099	.043	.470	.587	8739
				C		45.040	54.960		1.683	.065	.719	.899	13381
SH-7024 8S 41E S25 ABCA	53 to 63 ft.	199	Roland	A	36.300	28.615	29.211	5.875	.674	.035	.220	.419	7021
				B		44.921	45.857	9.223	1.058	.056	.345	.657	11022
				C		49.485	50.515		1.166	.061	.380	.724	12142
SH-7027 9S 42E S18 BDCA	52 to 61 ft.	202	Roland	A	35.790	27.573	29.647	6.990	.290	.021	.062	.207	7120
				B		42.942	46.172	10.886	.452	.032	.097	.323	11089
				C		48.188	51.812		.507	.036	.109	.362	12443
SH-7029 9S 42E S23 BBCB	68 to 76 ft.	203	Roland	A	30.230	37.275	27.767	4.728	.235	.015	.030	.190	8086
				B		53.426	39.798	6.776	.337	.022	.044	.272	11590
				C		57.310	42.690		.362	.023	.047	.292	12433

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 10.--Major constituents of ash, Roland coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-702 9S 40E S26 DDDA	53 to 63 ft.	159	Roland	10.9	21.6	13.2	.2	4.4	4.4	1.2	21.7	17.6	.5	95.7
SH-7019 9S 40E S36 ADDB	74 to 83 ft.	191	Roland	14.0	20.5	12.2	.2	3.4	6.3	2.4	23.9	11.8	.6	95.3
SH-7021 9S 41E S19 BAAC	54 to 65 ft.	195-196	Roland	17.8	16.2	5.9	1.7	2.8	1.2	1.0	43.5	7.3	.6	98.0
SH-7023 9S 41E S23 ACAB	30 to 31 ft.	198	Local	14.1	7.4	30.7	.9	3.4	.8	.1	32.4	5.6	.5	95.9
	166 to 170 ft.	201	Smith	10.9	1.3	3.3	1.7	.6	1.4	.3	73.8	1.6	.4	95.3
SH-7024 8S 41E S25 ABCA	53 to 63 ft.	199	Roland	16.2	17.4	9.3	.5	5.9	.7	3.0	26.9	17.4	.5	97.8
SH-7027 9S 42E S18 BDCA	52 to 61 ft.	202	Roland	18.6	12.9	6.2	1.2	3.5	4.6	1.4	38.2	8.5	.7	95.8
SH-7029 9S 42E S23 BBCB	68 to 76 ft.	203	Roland	14.3	14.5	4.7	.3	3.9	9.4	.4	37.5	11.8	1.5	98.3

Table 11.—Proximate analysis, forms of sulfur, and heating value, Squirrel Creek coal field.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7032			Roland	A	34.090	24.607	27.130	14.174	.196	.015	.058	.123	6608
9S R39E S11	28 to			B		37.334	41.162	21.505	.297	.022	.088	.187	10026
ACBB	36 ft.	205		C		47.562	52.438		.378	.028	.112	.238	12773
SH-7033			Roland	A	29.750	31.200	34.450	4.601	.259	.008	.079	.173	8082
8S R39E S34	38 to			B		44.412	49.039	6.549	.369	.011	.112	.246	11504
BDAB	46 ft.	206		C		47.525	52.475		.395	.012	.120	.263	12310
				A	30.050	28.709	34.573	6.667	.278	.008	.077	.193	7866
	46 to			B		41.043	49.426	9.532	.398	.011	.110	.276	11246
	48 ft.	207		C		45.367	54.633		.440	.012	.122	.305	12431
SH-7034			Roland	A	30.520	29.108	37.100	3.272	.624	.015	.169	.439	7996
8S R39E S20	35 to			B		41.895	53.396	4.709	.898	.022	.244	.632	11508
CDDB	42 ft.	208		C		43.965	56.035		.942	.023	.256	.663	12077
				A	28.560	31.124	36.808	3.508	.292	.000	.073	.219	8265
	42 to			B		43.567	51.523	4.910	.409	.000	.102	.307	11569
	46 ft.	209		C		45.816	54.184		.430	.000	.108	.323	12166
SH-7035			Roland	A	28.710	30.578	37.753	2.959	.198	.016	.063	.119	8286
9S R39E S21	35 to			B		42.892	52.957	4.150	.277	.022	.089	.166	11624
BABA	45 ft.	210		C		44.749	55.251		.289	.023	.093	.174	12127
SH-7036			Roland	A	36.710	28.155	31.887	3.248	.163	.007	.064	.092	7225
9S R39E S17	30 to			B		44.486	50.382	5.133	.258	.011	.101	.146	11416
ADCB	33 ft.	211		C		46.892	53.108		.272	.012	.107	.154	12034
				A	31.730	28.152	34.426	5.692	.344	.015	.090	.239	7462
	33 to			B		41.236	50.427	8.337	.503	.022	.131	.350	10930
	36 ft.	212		C		44.987	55.013		.549	.024	.143	.382	11924

[1] /A, as received; B, moisture free; C, moisture and ash free.

In the Deer Creek coal deposit (Pl. 2, 33) east of the Tongue River Reservoir, the Anderson, Dietz No. 1, and Dietz No. 2 coal beds are all separated by partings. Near the Tongue River Reservoir, the parting between the Anderson and Dietz No. 1 is about 20 feet but it increases eastward to 60 feet. The parting between the Dietz No. 1 and Dietz No. 2 ranges from 50 to 80 feet throughout the area.

In the Deer Creek coal field, the Anderson, Dietz No. 1, and Dietz No. 2 coal beds contain strippable reserves over a large area, but in various parts of the field the Anderson and Dietz No. 1 beds have burned, leaving reserves only in the Dietz No. 2 coal bed. The Anderson coal reserves are in sec. 12, 13, 14, 22, and 23, T. 9 S., R. 40 E., and in sec. 2, 3, 4, 5, 6, 8, 9, 10, 14, 16, 17, and 18, T. 9 S., R. 41 E. The Anderson coal bed in this area averages 20 feet in thickness. Where the Anderson bed has burned or has been removed by erosion, the Dietz No. 1 and Dietz No. 2 coal beds still contain strippable coal. The Dietz No. 1 coal extends throughout the area except in sec. 36, T. 8 S., R. 40 E., and sec. 1 and 2, T. 9 S., R. 40 E. Only the Dietz No. 2 bed remains unburned throughout the area. The principal reserves in the Dietz No. 1 and Dietz No. 2 coal beds include the west half of sec. 1 and sec. 2, 12, 13, and 14, T. 9 S., R. 40 E., and sec. 6, 7, and 8, T. 9 S., R. 41 E. The Dietz No. 1 and Dietz No. 2 coal beds are each about 18 feet thick.

Additional strippable reserves are inferred along Corral Creek in sec. 19, 20, 21, 22, 23, 27, 28, 29, 30, 31, and 32, T. 8 S., R. 41 E. The deposit is limited by the burn at the outcrop and by high ground to the southeast.

The Roland coal bed is approximately 350 feet above the top of the Anderson coal bed and underlies the high divides both east and west of the Tongue River. In the Roland (Pl. 3) and Squirrel Creek (Pl. 4) coal deposits, the thickness of the Roland bed ranges from 6 to 14 feet. The Smith coal bed is below the Roland and about 182 feet above the Anderson bed, as shown in drill hole SH-7022 in sec. 10, T. 9 S., R. 41 E.

COAL QUALITY

Core samples from the Roland, Smith, Anderson, Dietz No. 1, and Dietz No. 2 coal beds were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Results of analyses of cores from the Decker coal deposit are shown in Table 3, from the Deer Creek coal deposit in Table 7, from the Roland coal deposit in Table 9, and from the Squirrel Creek coal deposit in Table 11.

Table 12.–Major constituents of ash, Squirrel Creek coal field.

				Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7032 9S 39E S11 ACBB	28 to 36 ft.	205	Roland	20.0	7.3	4.1	2.5	3.7	.4	.6	55.9	4.0	.7	99.2
SH-7033 8S 39E S34 BDAB	38 to 48 ft.	206-207	Roland	15.8	26.6	8.3	.5	8.0	.9	1.1	23.4	13.4	.6	98.6
SH-7034 8S 39E S20 CDDB	35 to 46 ft.	208-209	Roland	15.8	23.9	7.2	.3	8.3	1.4	1.2	22.6	19.8	.7	101.2
SH-7035 9S 39E S21 BABA	35 to 45 ft.	210	Roland	11.7	28.5	7.7	.2	11.1	2.2	.9	21.5	13.1	.7	97.6
SH-7036 9S 39E S17 ADCB	30 to 36 ft.	211-212	Roland	14.6	27.6	8.8	.2	10.0	.3	1.6	18.1	14.0	.6	95.8

Bureau analyses of ash constituents are shown in Tables 6, 8, 10, and 12; these tables also include results reported by the U.S. Geological Survey laboratories, Denver. Trace-element analyses, shown in Tables 4 and 5, were reported by the U.S. Geological Survey laboratories, Denver, (U.S. Geological Survey Open-File Report, 1973). Analyses of four core samples from the combined Anderson and Dietz No. 1 coal beds reported that the Decker deposit showed a calorific value of 10,250 Btu, fixed carbon ranging from 30 to 45%, volatile matter ranging from 30 to 37%, moisture 15.60%, and ash 3.9% (Ayler, Smith, and Deutman, 1969, p. 17). Analyses of two core samples of the Dietz No. 2 bed, which has an average thickness of 18.2 feet, showed a calorific value of 9,600 Btu, fixed carbon 30 to 45%, volatile matter 34 to 43%, moisture 21.0%, and ash 4.87%. All values are reported on the "as received" basis, as determined by Pacific Power and Light Company, and they are comparable with the results obtained under our project.

COAL RESERVES

The coal reserves in the Decker area are shown individually by coal deposit on Table 2. Reserves in the Decker coal field (Pl. 1) total 2,239,990,000 tons in the Anderson, Dietz No. 1, and Dietz No. 2 coal beds. Reserves in the Deer Creek coal field (Pl. 2) total 495,650,000 tons, reported as 410,470,000 tons indicated and 85,180,000 inferred. Reserves in the Roland coal field (Pl. 3) total 218,040,000 tons, and in the Squirrel Creek (Pl. 4) coal deposit, 133,410,000 tons.

KIRBY COAL DEPOSIT

LOCATION

The Kirby coal deposit (Pl. 5A, B, and C) lies in T. 6 and 7 S., R. 39 and 40 E., and in the narrow strip on the eastern edge of T. 6 and 7 S., R. 38 E., that lies east of the Crow Indian Reservation boundary, Big Horn County. The maps of the Kirby area show strippable reserves in the Anderson and Wall coal beds (Pl. 5A), in the Dietz coal bed (Pl. 5B), and in the Canyon coal bed (Pl. 5C). The area is bounded on the north by the Northern Cheyenne Indian Reservation boundary, on the west by the Crow Indian Reservation boundary, and on the south by the limit of strippable coal or the area where burning has removed the coal. The eastern boundary is the eastern side of the divide between the Tongue River and Rosebud Creek or the area where burning has removed the coal.

FIELD WORK AND MAP PREPARATION

Extensive field work and interpretation were required on the Kirby area because of the structural complexity. Drilling was begun during the 1969 field season, and additional holes were drilled during the 1970 field season. In midwinter 1972-73, more holes were drilled to verify some of the interpretations and to assist in the final preparation of the maps. After the first drilling in 1969, preparation of a structure map was attempted, but the area was more complex than had been expected. In the summer of 1972, detailed field mapping on topographic maps and black-and-white photos was completed for six 7½-minute quadrangles extending from Rosebud Creek to the Tongue River in the vicinity of Birney. Much of the next winter was spent interpreting this work and in formulating the structure and overburden maps. Gulf Mineral Resources Company supplied colored aerial photos of the area, and Pat McDonough of Billings provided logs of drill holes in the Rosebud Creek area.

PREVIOUS GEOLOGIC WORK

The Kirby area was mapped and described in a U.S. Geological Survey report on the northern extension of the Sheridan coal field (Baker, 1929) and in a U.S. Bureau of Mines report on the strippable coal in Montana (Ayler, Smith, and Deutman, 1969).

LAND OWNERSHIP

Most of the surface is privately owned, with the exception of sec. 16 and 36 in each township, which are owned by the State of Montana, and a small amount of surface in T. 6 and 7 S., R. 40 E., which is public domain. Most of the coal, however, is owned by the Federal Government. The state owns the coal underlying its tracts, and some coal is owned in fee by individuals in the valley bottom along Rosebud Creek.

SURFACE FEATURES AND LAND USE

The surface features within the area of the Kirby coal deposit range from the rolling prairie on the high divide between the Tongue River and Rosebud Creek to the deeply incised valleys of Rosebud Creek and its steep tributaries that are bordered by rugged bluffs. Also prominent is the rugged topography on the east side of the divide where tributaries of the Tongue River such as Canyon Creek, Fourmile Creek, and Post Creek are deeply incised. Ponderosa pine grows on clinkered areas along the steep valley sides. Rosebud Creek flows north and joins the Yellowstone near Rosebud.

The principal land use is livestock grazing. Hay is raised along the narrow valleys of Rosebud Creek and some of its tributaries of the Tongue River on the east side of the divide. On part of the high divide area be-

Table 13.—Reserves, overburden, overburden ratio, acres, and tons/acre, Kirby coal deposit.

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
ANDERSON BED					
0 to 50	49.85	73.87	1.48	1,387.7	35,922.7
50 to 100	82.89	261.05	3.15	2,157.8	38,414.1
100 to 150	83.78	425.34	5.08	2,109.8	39,709.8
	Total 216.52	Total 760.26	Average 3.51	Total 5,655.3	Average 38,285.2
DIETZ BED					
0 to 50	180.00	232.93	1.29	4,371.2	41,178.6
50 to 100	243.95	681.78	2.79	5,632.0	43,314.9
100 to 150	248.02	1,097.66	4.43	5,440.0	45,591.9
150 to 200	80.00	290.74	3.63	1,030.4	77,639.8
200 to 250	82.38	379.58	4.61	1,043.2	78,968.6
	Total 834.35	Total 2,682.69	Average 3.22	Total 17,516.8	Average 47,630.9
CANYON BED					
0 to 50	19.56	27.94	1.42	524.7	37,278.44
50 to 100	58.31	180.89	3.10	1,495.2	38,998.12
100 to 150	78.31	400.45	5.11	1,986.4	39,423.07
150 to 200	2.35	17.0	7.23	60.3	38,971.80
	Total 158.53	Total 626.28	Average 3.95	Total 4,066.6	Average 38,983.42
WALL BED					
0 to 50	56.86	38.0	0.67	713.9	79,647.0
50 to 100	74.2	112.69	1.52	931.6	79,647.9
100 to 150	84.11	213.65	2.54	1,058.4	79,469.0
150 to 200	120.88	428.16	3.54	1,517.7	79,646.8
200 to 250	137.64	628.16	4.56	1,730.8	79,523.9
	Total 473.69	Total 1,420.66	Average 2.99	Total 5,952.4	Average 79,579.7

tween Rosebud Creek and the Tongue River, grain is cultivated by dry-land farming.

The area in sec. 16, 17, 18, 19, 20, 21, and 22, T. 7 S., R. 39 E., has historic value as the site of the battle between Captain Crook and the Sioux on June 17, 1876.

GEOLOGIC STRUCTURE

The relative complexity of the geologic structure in the Kirby area is the result of numerous faults, which have caused local reversal in the generally southeast dip of the Tongue River beds.

The Kirby coal deposit seems to occupy a zone where the trend of lineations changes from northwest to north-south and east-west. Along the valleys of Canyon Creek, Fourmile Creek, and Post Creek in T. 6 and 7 S., R. 40 E., the northwest lineations are obvious. In the Rosebud Creek tributaries, north-south and east-west lineations are visible. Rosebud Creek flows northward, and in the southwestern part of T. 7 S., R. 39 E., it seems to be controlled by this structural pattern.

The faults in the area, although difficult to see except in local small areas, are depicted graphically on Plate 33, cross section SC-K, as normal tensional features. They have been projected on the basis of surface mapping, color-photo interpretation, and drill-hole data. Displacement of most of the faults ranges from only a few feet to about 200 feet. In the northeast corner of T. 7 S., R. 39 E., a graben has dropped the Tongue River strata, as illustrated on Plate 5A, which shows the Anderson coal bed.

COAL BEDS

The strippable coal beds in the Kirby area are in the upper part of the Tongue River Member and include, from top to bottom, the Anderson, Dietz No. 1 and No. 2, the Canyon, and the Wall coal beds, all of which are correlated with beds of the same name in the Decker area. The Smith and Cook coal beds have also been mapped in the area. The Smith bed, above the Anderson bed, is 9 feet thick, as measured in drill hole SH-731A, in the NW¼ sec. 27, T. 7 S., R. 39 E. The Cook bed forms two benches lying between the Canyon and Wall coal beds. Thickness of the upper bench reaches 11 feet; the lower bench ranges from a trace to 3 feet.

The Anderson coal bed contains large strippable reserves. The bed is thickest near the Big Bend of the Rosebud, sec. 21 and 22, T. 7 S., R. 39 E., where it is 30 feet thick. It thins northeastward to 8 feet as in drill hole SH-41 in sec. 26, T. 6 S., R. 39 E. In drill hole SH-736, the Anderson coal bed has a thickness of 26 feet, and a lower bench 4 feet thick lies 3 feet below the thick end. The combined Dietz No. 1 and No. 2 is only 10 feet below the base of the lower bench of the Anderson coal bed in this area. The Anderson and Dietz beds split northward, as shown on the cross section SC-K, Plate 33.

The Dietz No. 1 and No. 2 beds are combined in the southwestern part of the mapped area and are almost 50 feet thick, but they thin and split northeastward. In the north part of the area (Pl. 5B), only the reserves in the Dietz No. 1 bed are included, although the Dietz No. 2 bed may contain additional reserves.

Because the Canyon coal bed crops out on the steep sides of Rosebud Creek valley, it does not contain nearly as large strippable reserves as the Anderson or the Dietz coal beds. The thickness trend exhibited by the Anderson and Dietz No. 1 and No. 2 coal beds is not followed by the Canyon coal bed. It is thickest in the northernmost part of the area, as in drill hole SH-36 in sec. 16, T. 6 S., R. 39 E., where it is 25 feet thick. It thins southward and is 16 feet thick in sec. 9, T. 7 S., R. 39 E.

The Wall coal bed is below the floor and along the sides of Rosebud Creek valley and along the floor of several tributary valleys in T. 6 S., R. 39 E. Steep-sided clinker-capped ridges along Rosebud Creek preclude stripping of the Wall coal bed in any very large areas. The coal bed is as much as 54 feet thick in the Kirby deposit, and the thickness averages nearly 50 feet in a large area extending into T. 7 S., R 39 and 40 E. Farther east in drill hole SH-50 in sec. 1, T. 7 S., R. 40 E., the Wall bed is 60 feet thick.

COAL QUALITY

Samples of the Anderson, Dietz No. 1, Dietz No. 2, and Canyon coal beds were obtained for analysis. Analytical results are shown in Tables 14 and 15.

COAL RESERVES

Strippable coal reserves in the Kirby coal deposit have been mapped in the Anderson, combined Dietz No. 1 and No. 2, Canyon, and Wall coal beds. Indicated reserves for these coal beds are shown on Table 13.

Total reserves are: Anderson coal bed, 216,520,000 tons; Dietz No. 1 and No. 2 beds, 834,350,000 tons; Canyon bed, 158,530,000 tons; Wall coal bed, 473,690,000 tons. The total strippable reserves are 1,683,090,000 tons.

Table 14.–Proximate analysis, forms of sulfur, and heating value, Kirby coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-31 7S 40E S8 ACAD	35 to 45 ft.	83	Anderson	A	29.490	26.757	35.636	8.116	.650	.064	.072	.514	7277
				B		37.948	50.341	11.511	.922	.091	.102	.729	10321
				C		42.885	57.115		1.042	.103	.116	.823	11664
	96 to 106 ft.	84	Dietz	A	28.310	28.679	38.096	4.914	.288	.033	.049	.206	8275
				B		40.005	53.140	6.855	.402	.046	.069	.287	11543
				C		42.949	57.051		.431	.049	.074	.308	12393
	106 to 112 ft.	85		A	29.800	28.002	39.066	3.132	.251	.008	.024	.219	8308
				B		39.889	55.649	4.462	.357	.012	.035	.311	11834
				C		41.752	58.248		.374	.012	.036	.326	12387
SH-35 6S 39E S14 BBCA	89 to 99 ft.	87	Dietz	A	28.230	29.772	35.313	6.684	.277	.000	.067	.210	8383
				B		41.483	49.203	9.313	.387	.000	.094	.293	11680
				C		45.743	54.257		.426	.000	.103	.323	12879
SH-36 6S 39E S16 BADC	104 to 113 ft.	77	Canyon	A	27.170	26.897	42.690	3.243	.224	.026	.052	.146	9113
				B		36.932	58.616	4.453	.307	.035	.071	.201	12513
				C		38.653	61.347		.321	.037	.074	.210	13096
	113 to 123 ft.	78		A	27.770	31.430	37.345	3.455	.216	.024	.040	.152	8446
				B		43.513	51.703	4.783	.300	.033	.055	.211	11693
				C		45.699	54.301		.315	.035	.058	.221	12281
	123 to 130 ft.	79		A	16.390	30.584	42.271	10.754	.280	.019	.075	.187	8808
				B		36.580	50.558	12.863	.335	.022	.089	.223	10534
				C		41.979	58.021		.384	.026	.102	.256	12089
SH-37 7S 39E S24 BBCB	40 to 49 ft.	80	Anderson	A	27.040	29.274	39.587	4.100	.262	.042	.042	.178	8391
				B		40.123	54.258	5.619	.359	.058	.058	.243	11500
				C		42.512	57.488		.381	.061	.061	.258	12185
	49 to 58 ft.	82		A	25.550	29.861	40.504	4.084	.212	.017	.051	.144	8637
				B		40.109	54.406	5.486	.285	.023	.068	.193	11601
				C		42.437	57.563		.301	.024	.072	.205	12275
	58½ to 60 ft.	81		A	26.630	30.934	38.558	3.878	.432	.042	.066	.324	8491
				B		42.162	52.552	5.286	.589	.057	.091	.441	11573
				C		44.515	55.485		.621	.060	.096	.466	12219
SH-38 7S 39E S11 DACD	73 to 81 ft.	88	Anderson	A	31.570	28.973	35.271	4.186	.368	.023	.078	.266	7708
				B		42.339	51.544	6.117	.537	.034	.114	.389	11263
				C		45.098	54.902		.573	.037	.122	.414	11999
	108 to 117 ft.	101		A	27.630	31.270	37.938	3.162	.185	.000	.042	.143	8422
				B		43.209	52.422	4.369	.256	.000	.058	.198	11637
				C		45.183	54.817		.267	.000	.061	.207	12169
	117 to 126 ft.	102		A	22.090	33.494	40.056	4.360	.326	.009	.045	.272	8864
				B		42.990	51.414	5.596	.419	.012	.058	.349	11378
				C		45.539	54.461		.444	.012	.062	.370	12052
SH-39 7S 39E S10 ADBB	70 to 74 ft.	108	Dietz No. 1	A	24.010	26.079	45.434	4.477	2.375	.377	.772	1.226	7467
				B		34.319	59.790	5.891	3.126	.497	1.016	1.614	9826
				C		36.467	63.533		3.322	.528	1.079	1.715	10441
SH-41 6S 39E S26 CADD	92 to 100 ft.	109	Dietz No. 1	A	27.870	31.853	35.320	4.957	.314	.033	.058	.223	8074
				B		44.160	48.967	6.872	.436	.046	.080	.310	11194
				C		47.419	52.581		.468	.049	.086	.333	12020

SH-56 7S R39E S18 DDCD	72 to 82 ft.	131	Anderson	A	27.200	30.133	38.411	4.255	.273	.016	.024	.233	8426
				B		41.392	52.763	5.845	.375	.022	.033	.320	11574
				C		43.962	56.038		.398	.023	.035	.340	12292
	82 to 90 ft.	132		A	28.400	30.210	38.130	3.260	.228	.000	.040	.190	8376
				B		42.193	53.254	4.553	.320	.000	.055	.265	11699
				C		44.205	55.795		.334	.000	.058	.278	12257
	90 to 97 ft.	133		A	25.910	31.378	38.270	4.443	.269	.017	.031	.171	8527
				B		42.351	51.653	5.996	.334	.023	.064	.431	11509
				C		45.052	54.948		.358	.024	.073	.461	12244
SH-107 7S R40E S30 BAAA	35 to 43 ft.	143	Anderson	A	22.370	33.406	40.821	3.403	.209	.018	.027	.163	8493
				B		43.032	52.584	4.384	.269	.023	.035	.210	10940
				C		45.006	54.994		.281	.024	.037	.220	11441
	90 to 94 ft.	144	Dietz No. 1	A	21.500	33.440	41.178	3.882	.222	.027	.044	.151	9073
				B		42.598	52.456	4.946	.283	.034	.057	.192	11558
				C		44.815	55.185		.298	.036	.060	.202	12160
	152 to 162 ft.	145	Dietz No. 2	A	24.910	30.216	41.266	3.608	.201	.017	.052	.131	8950
				B		40.240	54.955	4.805	.268	.023	.070	.174	11919
				C		42.271	57.729		.281	.024	.073	.183	12521
	162 to 172 ft.	146		A	22.040	32.262	41.968	3.729	.234	.018	.054	.162	9301
				B		41.383	53.833	4.784	.300	.023	.069	.207	11931
				C		43.462	56.538		.315	.024	.073	.218	12530
SH-722 6S R39E S35 CCBD	111 to 120 ft.	481	Dietz No. 1	A	27.930	30.994	36.682	4.395	.246	.015	.038	.192	8552
				B		43.005	50.897	6.098	.342	.021	.053	.267	11867
				C		45.798	54.202		.364	.022	.057	.284	12637
	120 to 130 ft.	482		A	31.140	28.776	36.899	3.184	.346	.015	.059	.273	8226
				B		41.790	53.586	4.624	.503	.021	.086	.396	11946
				C		43.816	56.184		.527	.022	.090	.413	12523
SH-7012 7S R40E S29 CDBC	98 to 107 ft.	174	Dietz No. 1	A	26.220	29.110	32.790	11.880	1.520	.042	.822	.656	8033
				B		39.455	44.443	16.102	2.061	.056	1.115	.890	10887
				C		47.027	52.973		2.456	.067	1.329	1.060	12977
	107 to 116 ft.	175		A	27.150	30.712	37.295	4.843	.360	.017	.075	.268	8952
				B		42.158	51.194	6.648	.494	.023	.103	.367	12288
				C		45.160	54.840		.529	.025	.111	.393	13163
	116 to 126 ft.	176		A	28.720	31.363	36.681	3.237	.229	.016	.057	.156	9507
				B		43.999	51.460	4.541	.322	.023	.080	.218	13337
				C		46.092	53.908		.337	.024	.084	.229	13971
	129 to 139	177		A	28.430	28.344	32.168	11.058	.398	.016	.089	.292	7488
				B		39.603	44.946	15.451	.556	.023	.125	.408	10463
				C		46.840	53.160		.657	.027	.148	.483	12375
	139 to 146 ft.	178		A	25.340	29.399	31.198	14.064	1.591	.040	.871	.680	8049
				B		39.377	41.786	18.837	2.131	.054	1.167	.910	10781
				C		48.516	51.484		2.626	.066	1.438	1.122	13283

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 15.–Major ash constituents, Kirby coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-31 7S 40E S8 ACAD	96 to 112 ft.	84-85	Dietz No. 1	9.6	35.4	3.5	.2	8.1	.4	.7	31.0	11.5	1.6	102.0
SH-35 6S 39E S14 BBCA	89 to 99 ft.	87	Dietz No. 1	16.1	14.5	4.0	.8	5.5	.3	1.2	43.1	7.7	1.1	94.3
SH-36 6S 39E S16 BADC	104 to 130 ft.	77-79	Canyon	12.4	18.8	5.5	1.6	6.6	1.5	.3	40.3	9.9	.6	97.5
SH-37 7S 39E S24 BBCB	40 to 60 ft.	80-82	Anderson	10.2	21.3	7.3	.3	5.3	7.6	.4	33.6	13.3	1.0	100.3
SH-38 7S 39E S11 DACD	108 to 126 ft.	101-102	Anderson	14.8	8.1	4.4	2.0	3.0	1.8	.2	56.2	6.3	.7	97.5
SH-39 7S 39E S10 ADBB	70 to 74 ft.	108	Dietz No. 1	20.5	6.0	12.6	.7	2.7	1.8	.3	48.3	5.6	.8	99.3
SH-41 6S 39E S26 CADD	92 to 100 ft.	109	Dietz No. 1	11.2	19.6	9.9	.3	5.1	7.4	.5	23.9	13.0	.2	91.1
SH-56 7S 39E S18 DDCD	72 to 97 ft.	131-133	Anderson	10.6	23.3	4.7	.3	5.6	6.3	.5	32.8	12.3	1.1	97.5
SH-107 7S 40E S30 BAAA	35 to 43 ft.	143	Anderson	17.8	25.0	3.2	.3	8.5	4.0	1.5	19.2	15.6	.8	95.9
	90 to 94 ft.	144	Dietz No. 1	12.2	18.5	3.3	.2	3.9	8.7	.6	35.9	9.0	1.0	93.3
	152 to 172 ft.	145-146	Dietz No. 2	17.6	23.4	2.6	.3	7.2	1.5	.3	28.1	13.7	1.1	95.8
SH-7012 7S 40E S29 CDBC	98 to 146 ft.	174-178	Dietz No. 1	18.2	7.8	6.7	1.9	4.3	1.6	.5	47.3	9.5	1.1	98.9

Table 16.—Reserves, overburden, overburden ratio, acres, and tons/acre, Canyon Creek coal deposit.

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
WALL BED					
0 to 50	246.73	204.44	.82	3,833.6	64,359.9
50 to 100	450.64	741.88	1.64	6,112.0	73,730.4
100 to 150	483.46	1,273.54	2.63	6,291.2	76,849.5
150 to 200	386.52	1,209.72	3.12	4,288.0	90,139.9
200 to 250	316.90	1,212.71	3.82	3,334.4	95,039.6
	Total 1,884.25	Total 4,642.29	Average 2.46	Total 23,859.2	Average 78,974.3
BREWSTER–ARNOLD BED					
0 to 50	4.69	7.84	1.67	147.2	31,861.4
50 to 100	30.38	115.39	3.79	953.6	31,858.2
100 to 150	30.79	194.85	6.32	966.4	31,860.5
	Total 65.86	Total 318.08	Average 4.82	Total 2,067.2	Average 31,859.5

CANYON CREEK COAL DEPOSIT

LOCATION

The Canyon Creek coal deposit is in portions of T. 5, 6, and 7 S., R. 40, 41, and 42 E., Big Horn and Rosebud Counties (Pl. 6). The area is limited on the east by the clinker of the Wall coal bed and by Tongue River, on the north by the boundary of the Northern Cheyenne Indian Reservation, and on the west by the increasing overburden on the Wall coal bed.

FIELD WORK AND MAP PREPARATION

The largest part of the field work in the Canyon Creek coal deposit was completed in 1969. Additional holes were drilled in 1970 along Fourmile Creek and Cook Creek. Coal outcrops, burn lines, clinkered areas, and faults were mapped in 1972 on aerial photos and 7½-minute topographic quadrangle maps.

PREVIOUS GEOLOGIC WORK

The Canyon Creek area was described in a U.S. Geological Survey report (Baker, 1929).

LAND OWNERSHIP

The Federal Government has large contiguous blocks of land within the area, and it is the largest single owner of surface. Private ownership is next, followed by the State of Montana, which owns each sec. 16 and 36, and then by the Burlington Northern, Inc., which owns some alternate sections along Cook Creek in T. 5 S., R. 41 and 42 E.

The Federal Government also owns the largest share of the coal in the area, but the next largest owner is the State of Montana (all sec. 16 and 36), followed by Burlington Northern, Inc. Private individuals own small tracts along Cook Creek and along some other tributaries of the Tongue River.

SURFACE FEATURES AND LAND USE

The topography of the area ranges from rugged to rolling. The rugged areas are capped by clinker along the sides of the valleys of Tongue River and its tributaries. Rolling topography characterizes the divides at the heads of the numerous northwest-trending valleys. Ponderosa pine grows on the clinkered areas along the steep valley sides.

The principal land use in the area is livestock grazing. Although virtually none of the area is cultivated, some hay is raised in meadows along the valley of the Tongue River.

Table 17.--Proximate analysis, forms of sulfur, and heating value, Canyon Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-42 2/ 7S 42E S9 ABDA	35 to 46 ft.	89	Wall	A	16.840	34.287	43.378	5.495	.472	.045	.145	.282	9675
				B		41.230	52.163	6.608	.568	.055	.175	.339	11634
				C		44.147	55.853		.608	.058	.187	.363	12457
SH-45 6S 41E S21 CDDA	57 to 66 ft.	112	Wall	A	24.370	31.963	40.068	3.599	.119	.025	.042	.051	8868
				B		42.262	52.979	4.759	.157	.034	.056	.067	11726
				C		44.374	55.626		.165	.035	.059	.071	12312
	66 to 75 ft.	113		A	24.030	29.685	41.476	4.810	.129	.026	.043	.060	8955
				B		39.074	54.595	6.331	.170	.034	.057	.079	11788
				C		41.715	58.285		.182	.036	.061	.085	12585
	75 to 84 ft.	114		A	23.030	31.108	42.465	3.397	.159	.018	.044	.097	9386
				B		40.416	55.171	4.413	.207	.023	.057	.126	12194
				C		42.282	57.718		.216	.024	.060	.132	12757
	84 to 94 ft.	115		A	25.970	28.861	38.613	6.556	.370	.069	.078	.224	8545
				B		38.985	52.159	8.856	.500	.093	.105	.303	11542
				C		42.773	57.227		.549	.102	.115	.332	12663
	94 to 104 ft.	116		A	26.000	28.734	40.716	4.549	.710	.076	.093	.541	8739
				B		38.830	55.022	6.148	.960	.103	.126	.731	11809
				C		41.373	58.627		1.023	.110	.134	.779	12582
SH-46 6S 41E S16 CABC	40 to 50 ft.	118	Wall	A	23.380	31.648	38.991	5.982	.290	.026	.061	.202	8892
				B		41.305	50.888	7.807	.378	.034	.080	.264	11605
				C		44.802	55.198		.410	.037	.087	.286	12588
	50 to 60 ft.	119		A	26.730	30.167	39.347	3.756	.216	.025	.041	.149	8606
				B		41.172	53.701	5.127	.294	.034	.057	.204	11746
				C		43.397	56.603		.310	.036	.060	.215	12381
	60 to 70 ft.	120		A	25.290	29.761	41.567	3.382	.156	.035	.052	.069	9045
				B		39.836	55.638	4.527	.208	.046	.069	.093	12107
				C		41.724	58.276		.218	.049	.073	.097	12681
	70 to 80 ft.	121		A	25.510	29.001	40.142	5.347	.411	.061	.123	.228	8735
				B		38.933	53.889	7.178	.552	.082	.164	.305	11727
				C		41.944	58.056		.595	.089	.177	.329	12634
	80 to 89 ft.	122		A	26.370	28.352	32.693	12.584	1.064	.194	.270	.600	7637
				B		38.507	44.402	17.091	1.445	.264	.367	.814	10373
				C		46.444	53.556		1.743	.318	.443	.982	12511
SH-49 6S 40E S24 CCCA	40 to 50 ft.	103	Wall	A	23.500	29.766	41.592	5.142	.225	.069	.078	.078	9303
				B		38.910	54.369	6.721	.295	.091	.102	.102	12161
				C		41.713	58.287		.316	.097	.109	.109	13038
	50 to 59 ft.	104		A	23.690	30.925	41.536	3.849	.208	.052	.052	.104	9480
				B		40.525	54.431	5.044	.273	.068	.068	.136	12423
				C		42.678	57.322		.287	.072	.072	.144	13083
	59 to 65 ft.	105		A	23.300	31.086	41.098	4.516	.173	.035	.069	.069	9030
				B		40.529	53.583	5.888	.226	.045	.090	.090	11773
				C		43.065	56.935		.240	.048	.096	.096	12510
	65 to 74 ft.	106		A	24.940	31.924	40.426	2.710	.147	.000	.043	.104	9316
				B		42.532	53.858	3.610	.195	.000	.057	.138	12411
				C		44.125	55.875		.203	.000	.060	.143	12876
	74 to 79 ft.	107		A	25.280	30.250	40.728	3.742	.153	.017	.051	.085	8738
				B		40.485	54.507	5.008	.205	.023	.068	.114	11695
				C		42.619	57.381		.216	.024	.072	.120	12311
SH-50 7S 40E S1 BDDD	200 to 209 ft.	91	Wall	A	26.090	28.050	41.727	4.133	.356	.034	.068	.254	9043
				B		37.951	56.457	5.592	.481	.046	.092	.344	12236
				C		40.199	59.801		.510	.049	.097	.364	12960

SH-50 7S 40E S1 BDDD	209 to 218 ft.	92	Wall	A	26.640	27.980	42.004	3.376	.226	.025	.075	.125	9191
				B		38.141	57.257	4.602	.308	.034	.103	.171	12529
				C		39.981	60.019		.322	.036	.107	.179	13134
	218 to 227 ft.	93		A	24.800	29.682	39.303	6.215	.227	.016	.065	.146	9175
				B		39.471	52.265	8.264	.301	.022	.086	.194	12201
				C		43.026	56.974		.328	.023	.094	.211	13300
	227 to 236 ft.	94		A	24.400	36.671	34.755	4.174	.227	.024	.057	.146	9419
				B		48.507	45.972	5.521	.301	.032	.075	.193	12459
				C		51.342	48.658		.318	.034	.080	.205	13187
	236 to 245 ft.	95		A	21.600	36.350	38.068	3.982	.370	.017	.059	.295	8590
				B		46.365	48.556	5.079	.472	.021	.075	.376	10957
				C		48.846	51.154		.498	.023	.079	.396	11543
	245 to 254 ft.	96		A	25.600	28.547	38.452	7.401	.208	.024	.080	.104	8587
				B		38.370	51.683	9.947	.280	.032	.108	.140	11541
				C		42.608	57.392		.310	.036	.119	.155	12816
	254 to 260 ft.	97		A	26.400	28.943	40.866	3.791	.446	.016	.072	.358	9062
				B		39.325	55.524	5.151	.606	.022	.097	.487	12313
				C		41.460	58.540		.639	.023	.103	.513	12981
SH-110 5S 41E S33 CBBB	150 to 159 ft.	147	Wall	A	22.360	30.858	40.991	5.790	.380	.062	.088	.229	8972
				B		39.745	52.797	7.458	.489	.080	.114	.296	11556
				C		42.948	57.052		.528	.086	.123	.319	12488
	159 to 163 ft.	148		A	20.220	33.868	40.788	5.124	.189	.018	.045	.126	9331
				B		42.452	51.125	6.423	.237	.023	.057	.158	11696
				C		45.366	54.634		.254	.024	.060	.169	12499
SH-121 6S 40E S12 AADD	130 to 140 ft.	154	Wall	A	21.520	30.227	40.182	8.070	1.115	.195	.513	.407	8725
				B		38.516	51.201	10.283	1.421	.248	.654	.519	11117
				C		42.931	57.069		1.584	.276	.729	.578	12392
	145 to 155 ft.	155		A	19.940	31.891	42.562	5.608	.167	.018	.044	.105	8996
				B		39.833	53.162	7.004	.208	.022	.055	.132	11236
				C		42.834	57.166		.224	.024	.059	.141	12083
	155 to 165 ft.	156		A	26.160	29.526	41.217	3.098	.128	.017	.034	.077	8940
				B		39.986	55.819	4.195	.173	.023	.046	.104	12107
				C		41.737	58.263		.181	.024	.048	.109	12637
	165 to 173 ft.	157		A	25.990	28.990	39.938	5.082	.236	.034	.067	.135	8764
				B		39.171	53.963	6.866	.319	.046	.091	.182	11841
				C		42.059	57.941		.342	.049	.098	.196	12714
SH-707 [2] 7S 41E S33 CCDC	73 to 83 ft.	165	Wall	A	23.390	29.799	42.858	3.953	.443	.017	.111	.315	9556
				B		38.897	55.944	5.160	.578	.022	.145	.411	12474
				C		41.013	58.987		.610	.023	.152	.434	13153
	83 to 92 ft.	166		A	24.660	23.325	47.055	4.960	.236	.025	.076	.135	9284
				B		30.960	62.457	6.583	.313	.034	.101	.179	12323
				C		33.142	66.858		.335	.036	.108	.191	13191
	92 to 103 ft.	167		A	24.490	29.455	42.275	3.780	.261	.025	.093	.143	9425
				B		39.008	55.987	5.006	.346	.033	.123	.190	12482
				C		41.063	58.937		.364	.035	.129	.200	13139
	103 to 113 ft.	168		A	23.310	30.831	42.559	3.299	.250	.017	.086	.147	9724
				B		40.203	55.495	4.302	.327	.023	.113	.191	12679
				C		42.010	57.990		.341	.024	.118	.200	13249
	113 to 123 ft.	169		A	23.600	29.179	42.599	4.622	.360	.017	.103	.240	10079
				B		38.193	55.758	6.049	.471	.022	.135	.314	13192
				C		40.652	59.348		.502	.024	.143	.334	14041

[1] /A, as received; B, moisture free; C, moisture and ash free.

[2] /Not shown on map.

Table 17 (Continued).

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-707 7S 41E S33 CCDC	123 to 128 ft.	170	Wall	A	24.450	29.561	42.273	3.716	.422	.017	.068	.338	9316
				B		39.128	55.953	4.919	.559	.022	.089	.447	12331
				C		41.152	58.848		.588	.024	.094	.470	12969
SH-7013 7S 41E S21 CACC	84 to 94 ft.	179	Wall	A	25.670	32.125	37.065	5.141	.352	.016	.064	.272	8910
				B		43.219	49.865	6.916	.474	.022	.086	.366	11988
				C		46.430	53.570		.509	.023	.093	.393	12878
	94 to 103 ft.	180		A	25.280	30.837	40.492	3.391	.187	.008	.049	.130	9206
				B		41.270	54.191	4.539	.250	.011	.065	.174	12320
				C		43.232	56.768		.262	.011	.068	.182	12906
	103 to 108 ft.	181		A	24.840	31.678	39.027	4.455	.181	.000	.033	.148	9153
				B		42.148	51.925	5.927	.241	.000	.044	.197	12177
				C		44.804	55.196		.256	.000	.047	.209	12945
	108 to 115 ft.	182		A	24.160	33.582	39.317	2.941	.173	.000	.033	.140	9514
				B		44.280	51.841	3.878	.228	.000	.043	.185	12544
				C		46.067	53.933		.237	.000	.045	.192	13050
	115 to 124 ft.	183		A	26.220	29.188	42.060	2.533	.144	.000	.032	.112	9251
				B		39.560	57.007	3.433	.195	.000	.043	.152	12538
				C		40.967	59.033		.202	.000	.045	.157	12984
	124 to 132 ft.	184		A	27.660	32.402	36.182	3.756	.264	.000	.032	.232	8953
				B		44.792	50.017	5.192	.365	.000	.044	.320	12376
				C		47.245	52.755		.384	.000	.047	.338	13054
	132 to 136 ft.	185		A	25.870	32.937	38.590	2.603	.251	.000	.041	.211	9566
				B		44.431	52.057	3.512	.339	.000	.055	.284	12904
				C		46.048	53.952		.352	.000	.057	.295	13373
SH-7057 5S 42E S28 DCDC	102 to 110 ft.	266	Brewster-Arnold	A	24.900	27.954	34.621	12.525	.553	.017	.145	.392	7979
				B		37.222	46.100	16.678	.737	.023	.193	.522	10625
				C		44.673	55.327		.884	.027	.231	.626	12751
	110 to 118 ft.	267		A	26.650	28.651	38.050	6.649	.291	.016	.024	.251	8494
				B		39.060	51.875	9.065	.397	.022	.033	.342	11580
				C		42.954	57.046		.437	.024	.036	.376	12735
	118 to 122 ft.	268		A	26.790	39.726	29.988	3.496	.357	.017	.043	.298	8859
				B		54.263	40.962	4.775	.488	.023	.058	.407	12100
				C		56.984	43.016		.512	.024	.061	.427	12707
SH-47 6S 40E S3 ACBA	55 to 60 ft.	123	Canyon	A	28.400	28.872	35.980	6.747	.651	.047	.063	.541	8006
				B		40.324	50.252	9.424	.909	.066	.088	.756	11181
				C		44.520	55.480		1.004	.073	.097	.835	12345
	60 to 70 ft.	124		A	28.800	29.492	37.962	3.745	.298	.039	.047	.212	7759
				B		41.422	53.318	5.260	.418	.055	.066	.297	10897
				C		43.722	56.278		.441	.058	.070	.314	11502
	70 to 80 ft.	125		A	30.400	27.308	38.216	4.075	.337	.031	.069	.237	8209
				B		39.236	54.909	5.855	.484	.044	.099	.341	11795
				C		41.676	58.324		.514	.047	.105	.362	12529
	80 to 90 ft.	126		A	25.600	21.019	22.197	31.184	3.242	.275	2.213	.753	8719
				B		28.252	29.834	41.914	4.357	.369	2.975	1.013	11719
				C		48.638	51.362		7.501	.636	5.122	1.744	20174
SH-48 6S 40E S16 AAAA	48 to 58 ft.	127	Canyon	A	22.120	30.181	41.610	6.090	.188	.036	.054	.098	8914
				B		38.753	53.428	7.819	.241	.046	.069	.126	11446
				C		42.040	57.960		.261	.050	.075	.137	12417
	58 to 68 ft.	128		A	26.060	28.185	42.669	3.086	.213	.026	.051	.136	8776
				B		38.118	57.708	4.174	.288	.035	.069	.184	11869
				C		39.779	60.221		.301	.036	.072	.193	12386
	68 to 78 ft.	129		A	26.440	23.731	32.458	17.371	.575	.058	.283	.233	6958
				B		32.261	44.125	23.615	.782	.079	.385	.317	9458
				C		42.234	57.766		1.024	.104	.504	.415	12382

1/A, as received; B, moisture free; C, moisture and ash free.

Table 18.—Major ash constituents, Canyon Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-42 7S 42E S9 ABDA	35 to 46 ft.	89	Wall	15.3	11.9	4.4	1.2	8.8	3.0	.5	40.2	10.6	.8	96.7
SH-45 6S 41E S21 CDDA	57 to 104 ft.	112-116	Wall	16.6	9.2	10.9	.9	3.4	2.0	.3	43.4	9.6	.8	97.1
SH-46 6S 41E S16 CABC	40 to 89 ft.	118-122	Wall	12.3	16.1	4.6	.3	4.3	5.7	.2	40.5	12.2	1.0	97.2
SH-49 6S 40E S24 CCCA	40 to 79 ft.	103-107	Wall	15.0	18.0	4.0	.3	10.0	1.3	.5	33.5	10.1	.8	93.5
SH-50 7S 40E S1 BDDD	200 to 260 ft.	91-97	Wall	17.6	14.0	3.7	.4	2.2	12.7	.3	32.8	12.7	.8	97.2
SH-110 5S 41E S33 CBBB	150 to 163 ft.	147-148	Wall	13.7	18.4	4.9	.2	6.6	2.1	.6	37.0	13.6	1.1	98.2
SH-121 6S 40E S12 AADD	130 to 173 ft.	154-157	Wall	13.8	10.8	6.8	.7	6.1	1.0	.1	44.1	13.6	.8	97.8
SH-707 7S 41E S33 CCDC	73 to 128 ft.	165-170	Wall	15.2	15.8	4.4	.3	6.1	3.4	.6	38.5	13.4	1.1	98.8
SH-7013 7S 41E S21 CACC	84 to 136 ft.	179-185	Wall	15.9	15.1	4.5	.5	2.1	12.6	.6	35.3	13.0	.9	100.5
SH-7057 5S 42E S28 DCDC	102 to 122 ft.	266-268	Brewster-Arnold	24.9	7.4	2.9	.4	2.0	5.9	.8	44.0	6.7	1.0	96.0
SH-47 6S 40E S3 ACBA	55 to 90 ft.	123-126	Canyon	12.3	18.5	4.6	.5	5.2	6.9	.6	29.1	14.0	.8	92.5
SH-48 6S 40E S16 AAAA	48 to 78 ft.	127-129	Canyon	12.8	18.6	3.9	.5	5.9	3.0	1.1	33.9	16.0	.6	96.3

GEOLOGIC STRUCTURE

The strata dip gently to the southeast 40 to 80 feet per mile. Numerous reversals are associated with faulting in the southern part of T. 6 S., R. 41 E., and the northern part of T. 7 S., R. 41 E., where dips are as much as three degrees next to the fault traces. These faults are easily discernible on aerial photos in the areas where they are shown on Plate 6 as solid lines.

COAL BEDS

The principal coal beds in the Canyon Creek coal deposits are the Canyon, Wall, and Brewster-Arnold beds. The Canyon bed is 200 to 250 feet above the Wall bed where drilled near Prairie Dog Creek and the north fork of Canyon Creek. Drill hole SH-47, sec. 3, and SH-48, sec. 16, T. 6 S., R. 40 E., penetrated thicknesses of 28 and 29 feet, respectively. Strippable reserves are not shown for the Canyon bed, however, because it could be strip mined only in the narrow valley bottom along Prairie Dog Creek and some of the forks of Canyon Creek. The steep slopes along the sides of the narrow valleys restrict the strippable areas because of the excessive overburden.

The Wall coal bed has been drilled throughout the area. Its thickness ranges from 32 feet in drill hole SH-110, sec. 33, T. 5 S., R. 41 E., in the northern part of the area to 60 feet in drill holes SH-50, sec. 1, T. 7 S., R. 40 E., and SH-49, sec. 24, T. 6 S., R. 40 E. Even though the Wall coal bed is thinnest in the northern part of the area, strippable coal is outlined along Cook Creek in T. 5 S., R. 41 and 42 E.

The Brewster-Arnold coal bed is 18 feet thick and forms two benches, which are separated by a parting 2 feet thick, as shown in drill hole SH-7057, sec. 28, T. 5 S., R. 42 E. This corresponds well with the measured thicknesses of the Brewster-Arnold coal bed in the Birney coal field (Pl. 7).

COAL QUALITY

Core samples were obtained from the Canyon, Wall, and Brewster-Arnold coal beds. Analytical results on these core samples are shown in Tables 17 and 18.

COAL RESERVES

Strippable reserves in the Wall and Brewster-Arnold coal beds total 1,950,110,000 tons. The Wall bed accounts for 1,884,250,000 tons and the Brewster-Arnold bed for 65,860,000 tons (Table 16).

BIRNEY COAL DEPOSIT

LOCATION

The Birney coal deposit (Pl. 7) is in T. 6 and 7 S., R. 41 and 42 E., Rosebud County. The deposit occupies the valleys of Tongue River and its tributaries. Its western part is overlapped by the Canyon Creek deposit (Pl. 6).

FIELD WORK AND MAP PREPARATION

The drilling program in the Birney area was completed in 1969. In 1972 the area was mapped on 7½-minute topographic maps and black-and-white aerial photos.

PREVIOUS GEOLOGIC WORK

This deposit was described in the U.S. Geological Survey report on the northern extension of the Sheridan coal field (Baker, 1929). Ayler, Smith, and Deutman (1969) included it in their report on the strippable coal in Montana.

LAND OWNERSHIP

Most of the surface in the Birney coal field is privately owned with the exception of sec. 16 and 36 in each town-

Table 19.--Reserves, overburden, overburden ratio, acres, and tons/acre, Birney coal deposit.

BREWSTER–ARNOLD BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	50.52	105.63	2.09	1,977.6	25,546.1
50 to 100	58.41	289.63	4.95	2,387.2	24,467.9
100 to 150	71.62	525.33	7.33	2,604.8	27,495.4
	Total 180.55	Total 920.59	Average 5.09	Total 6,969.6	Average 25,905.4

Table 20.–Proximate analysis, forms of sulfur, and heating value, Birney coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-43			Brewster-	A	24.980	29.494	40.938	4.588	.241	.034	.112	.095	8786
6S 42E S32	54 to		Arnold	B		39.315	54.569	6.115	.321	.046	.149	.126	11711
ABBD	64 ft.	99		C		41.876	58.124		.342	.049	.159	.134	12474
SH-44			Brewster-	A	24.400	29.574	41.492	4.534	.347	.025	.033	.289	9191
6S 42E S31	70 to		Arnold	B		39.120	54.883	5.997	.459	.033	.044	.382	12158
DBCB	75 ft.	110		C		41.615	58.385		.488	.035	.046	.407	12933
				A	23.600	33.550	39.722	3.128	.708	.034	.067	.607	9389
	75 to			B		43.913	51.992	4.094	.927	.044	.088	.795	12289
	83 ft.	111		C		45.788	54.212		.967	.046	.092	.829	12814
SH-114 2/			Brewster-	A	19.500	31.676	40.558	8.266	.367	.018	.110	.239	9417
6S 43E S20	90 to		Arnold	B		39.350	50.382	10.268	.456	.023	.137	.297	11698
BDAB	94 ft.	149		C		43.853	56.147		.509	.025	.153	.331	13036
				A	21.150	29.757	44.191	4.902	.236	.027	.072	.136	7987
	94 to			B		37.738	56.045	6.217	.299	.034	.092	.172	10130
	99 ft.	150		C		40.240	59.760		.319	.037	.098	.184	10801
SH-116			Brewster-	A	18.290	31.328	43.697	6.684	.292	.028	.075	.189	9346
6S 42E S27	60 to		Arnold	B		38.341	53.479	8.180	.358	.035	.092	.231	11438
CBCA	66 ft.	151		C		41.757	58.243		.390	.038	.101	.251	12457
				A	22.760	30.726	42.545	3.969	.725	.071	.141	.513	9274
	66 to			B		39.780	55.081	5.138	.938	.092	.183	.664	12007
	74 ft.	152		C		41.935	58.065		.989	.097	.193	.700	12658

1/A, as received; B, moisture free; C, moisture and ash free.

2/ Not shown on map.

Table 21.–Major ash constituents, Birney coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-43 6S 42E S32 ABBD	54 to 64 ft.	99	Brewster- Arnold	20.6	11.0	5.5	.6	3.4	7.3	1.0	35.8	11.1	.7	97.0
SH-44 6S 42E S31 DBCB	70 to 83 ft.	110-111	Brewster- Arnold	16.4	16.4	5.5	.3	10.9	4.5	.6	28.3	18.9	.7	102.5
SH-114 6S 43E S20 BDAB	90 to 99 ft.	149-150	Brewster- Arnold	18.6	11.8	3.3	1.3	3.3	10.9	.4	33.7	7.9	.9	92.1
SH-116 6S 42E S27 CBCA	60 to 74 ft.	151-152	Brewster- Arnold	17.9	13.8	4.0	.3	8.4	2.5	.8	33.2	15.3	1.0	97.2

ship, which are owned by the State of Montana. The Federal Government owns some of the surface a short distance west of the main valley of the Tongue River. Some coal in the valley bottom along Tongue River and its tributaries is privately owned, and the State of Montana has the coal rights on its land, but the Federal Government owns the rest, which is the largest share of the coal.

SURFACE FEATURES AND LAND USE

The Tongue River flows through the area in a northeasterly direction and has cut a deep valley bordered by clinker-topped ridges and knobs. Steep and rugged valley sides border a narrow flood plain. The northwest-trending tributaries east of the Tongue River are relatively short and steep; the southeast-trending tributaries west of the river are longer. Ponderosa pine trees grow on the steep sides of the tributary valleys and on large clinkered areas.

The principal land use in the area is livestock grazing. Hay is raised in meadows along the flood plain of the Tongue River.

GEOLOGIC STRUCTURE

The strata dip gently to the southeast. In drill hole SH-33, sec. 12, T. 6 S., R. 41 E., the Brewster-Arnold coal bed is 105 feet higher than in drill hole SH-43, sec. 32, T. 6 S., R. 42 E.

COAL BEDS

The Brewster-Arnold coal bed contains strippable reserves in the Birney area. Where the bed is exposed above river level, it has burned along its outcrop in the northern part of the area. The Wall coal bed, which is about 275 feet higher, has burned along the Tongue River and its clinker caps the buttes and ridges. The Brewster-Arnold coal bed is 20 feet thick in drill hole SH-43, sec. 32, T. 6 S., R. 42 E. The bed thins westward and develops a parting, which thickens westward. A gamma log in SE¼ sec. 24, T. 6 S., R. 41 E., shows that the Brewster-Arnold coal bed there forms two benches; the upper 10 feet thick and the lower 6 feet thick, separated by a 2-foot parting. This parting thickens westward and is 10 feet thick in the NW¼ sec. 21, T. 6 S., R. 41 E., as shown by a gamma log of an oil well. On this log, the upper bench is 11 feet thick and the lower, 6 feet.

COAL QUALITY

An earlier U.S. Bureau of Mines analysis of a sample from the abandoned Brewster-Arnold mine, sec. 23, T. 6 S., R. 42 E., agrees closely with our later analysis, which reports moisture on the "as received" basis as 27.3%, volatile matter 28.9%, fixed carbon 39.2%, ash 4.6%, sulfur 0.6%, and heating value 8,850 Btu.

Seven core samples obtained from the Brewster-Arnold coal bed during the current project were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, sulfur forms, and calorific value are shown in Table 20, and major ash constituents are shown in Table 21.

COAL RESERVES

Strippable coal reserves in the Brewster-Arnold coal bed total 180,550,000 tons (Table 19).

Table 22.–Reserves, overburden, overburden ratio, acres, and tons/acre, Poker Jim Lookout coal deposit.

ANDERSON and DIETZ BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	175.73	237.71	1.35	4,166.4	42,177.9
50 to 100	462.21	1,485.94	3.21	11,744.0	39,357.1
100 to 150	144.93	528.91	3.65	2,419.2	59,908.2
150 to 200	89.78	377.29	4.20	1,280.0	70,140.6
Total	872.65	Total 2,629.85	Average 3.01	Total 19,609.6	Average 44,501.2

POKER JIM LOOKOUT COAL DEPOSIT

LOCATION

The Poker Jim Lookout coal deposit (Pl. 8) in T. 6 and 7 S., R. 44 and 45 E., in Powder River and Rosebud Counties, is on a high divide between Otter Creek to the east and Hanging Woman Creek to the west. The area is within the boundary of the Custer National Forest and adjoins the Hanging Woman Creek coal deposit (Pl. 9A and B) to the south.

FIELD WORK AND MAP PREPARATION

Field work in the Poker Jim Lookout area, begun in 1969, included the drilling of four holes. One hole, drilled in 1970, penetrated lower coal beds in sec. 9, T. 7 S., R. 44 E. The geology was mapped with the help of color aerial photos borrowed from the Custer National Forest Service; overburden maps were prepared on 7½-minute topographic maps.

PREVIOUS GEOLOGIC WORK

The northern part of the Poker Jim Lookout coal deposit was included in the U.S. Geological Survey report on the Birney-Broadus coal field (Warren, 1959). The southern part was included in a U.S. Geological Survey open-file report on the Moorhead coal field (Bryson and Bass, 1966).

LAND OWNERSHIP

The Poker Jim Lookout coal deposit lies within the Custer National Forest.

SURFACE FEATURES AND LAND USE

The Poker Jim Lookout deposit is on the divide between Otter Creek and the East Fork of Hanging Woman Creek, an intermittent tributary of the Tongue River. The top of the divide is smooth, rolling, and covered with native grasses, but the edges are steep and rugged where thick clinker occurs. The clinkered areas and the valley sides support lush growths of ponderosa pine and other trees.

The principal land use is livestock grazing. Many nearby ranchers have grazing permits on Forest Service land.

GEOLOGIC STRUCTURE

The strata in the Poker Jim Lookout coal deposit dip to the south at 40 feet per mile.

COAL BEDS

Beds of economic importance in the Poker Jim Lookout deposit are the Anderson and Dietz coal beds, which converge in T. 6 S., R. 44 E., to form a coal bed 58 feet thick, as shown in drill hole SH-8, in sec. 9, T. 6 S., R. 44 E. In drill hole SH-7, in sec. 24, the two beds are separated by a parting of 17 feet and have a combined thickness of 59 feet. The parting thickens southward, and in sec. 36 it is 40 feet thick according to a gamma log. In SH-7, the Dietz coal bed is 25 feet thick, but it thins southward to 14 feet, as shown in the gamma log. Thickness of the Anderson bed is almost uniform, being 34 feet in SH-7 and 31 feet in SH-5 and SH-6.

COAL QUALITY

Eleven core samples obtained during the field evaluation were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, sulfur forms, and heating value are shown in Table 23. Major ash constituents are shown in Table 24.

COAL RESERVES

Reserves in the Anderson and Dietz coal beds total 872,650,000 tons (Table 22).

Table 23.—Proximate analysis, forms of sulfur, and heating value, Poker Jim Lookout coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-5 7S R44E S13 ADBA	94 to 104 ft.	16	Anderson	A	27.540	31.587	36.770	4.103	.184	.050	.000	.134	8203
				B		43.592	50.745	5.663	.254	.069	.000	.185	11321
				C		46.209	53.791		.270	.074	.000	.196	12000
	104 to 109 ft.	17		A	27.390	31.455	37.046	4.109	.278	.000	.017	.261	8374
				B		43.321	51.020	5.659	.383	.000	.023	.359	11533
				C		45.919	54.081		.406	.000	.025	.381	12225
SH-6 7S R44E S11 ABBB	163 to 172 ft.	18	Anderson	A	27.000	32.853	31.246	8.902	.876	.085	.332	.459	7826
				B		45.003	42.802	12.194	1.200	.116	.454	.629	10721
				C		51.253	48.747		1.366	.133	.517	.716	12210
SH-7 6S R44E S24 BDCB	186 to 196 ft.	59	Anderson	A	30.580	28.830	36.337	4.253	.087	.008	.016	.063	7770
				B		41.529	52.343	6.127	.126	.011	.023	.091	11193
				C		44.240	55.760		.134	.012	.024	.097	11924
SH-8 6S R44E S9 ACCC	105 to 115 ft.	60	Anderson	A	31.870	27.590	32.767	7.773	.761	.023	.206	.533	7637
				B		40.496	48.095	11.409	1.117	.034	.302	.782	11209
				C		45.711	54.289		1.261	.038	.341	.883	12653
	115 to 123 ft.	61		A	31.400	29.176	35.264	4.160	.298	.023	.054	.222	8007
				B		42.531	51.405	6.065	.435	.033	.078	.323	11672
				C		45.277	54.723		.463	.036	.083	.344	12426
	123 to 131 ft.	62		A	31.970	28.539	35.534	3.957	.230	.023	.069	.138	7715
				B		41.951	52.233	5.816	.337	.034	.101	.202	11340
				C		44.541	55.459		.358	.036	.108	.215	12040
	131 to 141 ft.	63		A	29.260	30.074	35.708	4.958	.286	.024	.056	.207	7874
				B		42.513	50.478	7.009	.405	.034	.079	.292	11131
				C		45.717	54.283		.436	.036	.085	.315	11970
SH-7038 7S R44E S9 DCBC	33 to 43 ft.	213	Canyon	A	30.000	30.522	32.146	7.332	.660	.015	.250	.395	7862
				B		43.602	45.923	10.475	.943	.022	.358	.564	11231
				C		48.704	51.296		1.054	.024	.400	.630	12545
	43 to 53 ft.	214		A	30.560	30.251	35.428	3.761	.165	.022	.082	.060	8801
				B		43.565	51.020	5.416	.237	.032	.119	.086	12675
				C		46.059	53.941		.251	.034	.125	.091	13400
	53 to 63 ft.	215		A	30.890	27.624	37.575	3.912	.289	.016	.070	.203	7939
				B		39.971	54.369	5.660	.419	.023	.102	.294	11487
				C		42.369	57.631		.444	.024	.108	.312	12177

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 24.–Major ash constituents, Poker Jim Lookout coal deposit.

Drill hole and location	Depth sampled	Sample number	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-5 7S 44E S13 ADBA	94 to 109 ft.	16-17	Anderson	13.1	26.2	4.5	.3	6.7	11.9	.5	24.1	10.8	1.0	99.1
SH-6 7S 44E S11 ABBB	163 to 172 ft.	18	Anderson	14.2	9.6	9.0	1.3	3.4	6.7	.4	35.3	16.4	.6	96.9
SH-7 6S 44E S24 BDCB	186 to 196 ft.	59	Anderson	12.8	18.7	5.4	.8	4.4	12.0	.2	28.3	8.4	.7	91.7
SH-8 6S 44E S9 ACCC	105 to 141 ft.	60-63	Anderson	15.6	19.5	4.2	.6	6.9	3.6	.8	28.0	17.2	1.0	97.4
SH-7038 7S 44E S9 DCBC	33 to 63 ft.	213-215	Canyon	13.9	18.5	5.8	.7	10.0	2.6	.3	31.7	14.6	.7	98.8

Table 25.—Reserves, overburden, overburden ratio, acres, and tons/acre, Hanging Woman Creek coal deposit.

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/tons	Acres	Tons/acre
ANDERSON and DIETZ BEDS					
0 to 50	599.87	370.81	0.61	17,593.6	34,095.9
50 to 100	1,420.92	5,260.47	3.70	43,404.8	32,736.5
100 to 150	683.46	2,672.48	3.91	13,203.2	51,764.7
	Total 2,704.25	Total 8,303.76	Average 3.07	Total 74,201.6	Average 36,444.6
ANDERSON BED					
0 to 50	296.95	313.82	1.05	5,849.6	50,764.2
50 to 100	602.88	1,395.47	2.31	11,494.4	52,451.7
100 to 150	683.46	2,672.48	3.91	13,203.2	51,765.5
	Total 1,583.29	Total 4,381.77	Average 2.76	Total 30,547.2	Average 51,830.9
DIETZ BED					
0 to 50	302.92	56.99	0.18	11,744.0	25,793.6
50 to 100	818.04	3,865.00	4.72	31,910.4	25,635.9
	Total 1,120.96	Total 3,921.99	Average 3.49	Total 43,654.4	Average 25,678.1

HANGING WOMAN CREEK COAL DEPOSIT

LOCATION

The Hanging Woman Creek coal deposit (Pl. 9), in T. 7, 8, and 9 S., R. 42, 43, 44, and 45 E., is bounded on the west by the high ridge between Hanging Woman Creek and the Tongue River valley, where increasing thickness of overburden makes strip mining impractical. On the south also it is bounded by excessive overburden. On the east, it abuts the West Moorhead coal deposit (Pl. 10A, B, and C). On the north, rugged topography and the outcrop of the coal beds limit the deposit. In T. 7 S., R. 44 E., the deposit joins the Poker Jim Lookout coal deposit (Pl. 8), which has reserves in the same coal beds.

FIELD WORK AND MAP PREPARATION

Drilling in the Hanging Woman Creek area, begun in 1969, was completed in 1970. Outcrops of coal beds and limits of clinker were mapped in 1969; this work was supplemented by geologic interpretation of color photos borrowed from the U.S. Forest Service and of infrared color transparencies borrowed from the U.S. Bureau of Land Management, Billings. Oil well logs in the area gave excellent information, because gamma logs were run to the surface. Drill logs of water wells in part of the area were obtained from the Kendrick Land and Cattle Company.

PREVIOUS GEOLOGIC WORK

Portions of the Hanging Woman Creek area were mapped and described in a U.S. Geological Survey report (Baker, 1929) and in an open-file report on the Moorhead coal field (Bryson and Bass, 1966). Ayler, Smith, and Deutman (1969) in describing the strippable coal in Montana, included a deposit in the Dietz No. 1 coal bed along the valley of Hanging Woman Creek.

LAND OWNERSHIP

The State of Montana owns a large part of T. 8 S., R. 43 E., but in the other townships the state owns only sec. 16 and 36. The Federal Government owns scattered surface tracts throughout the area and the rest of the surface is privately owned.

Although the Federal Government conveyed the surface to private individuals, it retained ownership of the coal in most of the area. The State of Montana owns the

Table 26.--Proximate analysis, forms of sulfur, and heating value, Hanging Woman Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-1 8S R45E S7 CAAD	100 to 108 ft.	2	Anderson	A	20.600	32.943	41.534	4.923	.282	.027	.064	.191	9259
				B		41.490	52.309	6.201	.355	.034	.080	.241	11661
				C		44.233	55.767		.379	.037	.086	.257	12432
	108 to 118 ft.	3		A	24.400	31.899	39.514	4.187	.262	.026	.044	.192	8718
				B		42.195	52.267	5.538	.346	.035	.058	.254	11531
				C		44.668	55.332		.366	.037	.061	.269	12207
SH-2 8S R44E S12 BCCC	83 to 93 ft.	6	Anderson	A	27.260	31.072	38.008	3.660	.204	.025	.025	.155	8440
				B		42.716	52.252	5.032	.281	.034	.034	.213	11603
				C		44.979	55.021		.296	.035	.035	.225	12218
	93 to 103 ft.	7		A	28.180	31.238	36.510	4.073	.330	.040	.064	.225	8151
				B		43.494	50.835	5.671	.459	.056	.090	.314	11349
				C		46.109	53.891		.487	.059	.095	.333	12032
	103 to 111 ft.	8		A	26.830	30.897	37.667	4.606	.350	.041	.057	.252	8281
				B		42.226	51.479	6.294	.478	.056	.078	.345	11318
				C		45.063	54.937		.510	.059	.083	.368	12078
	111 to 112 ft.	9		A	27.000	29.920	39.855	3.225	.780	.114	.138	.528	7865
				B		40.986	54.596	4.418	1.068	.156	.189	.723	10775
				C		42.880	57.120		1.118	.163	.198	.757	11273
SH-3 8S R44E S3 DCCA	88 to 98 ft.	10	Anderson	A	27.400	29.752	38.542	4.306	.204	.042	.042	.119	8544
				B		40.980	53.088	5.931	.281	.058	.058	.164	11769
				C		43.564	56.436		.298	.062	.062	.174	12511
	98 to 108 ft.	11		A	28.400	30.283	34.929	6.388	.224	.025	.025	.174	8706
				B		42.294	48.783	8.922	.313	.035	.035	.243	12160
				C		46.438	53.562		.344	.038	.038	.267	13351
	108 to 116 ft.	12		A	27.150	29.364	37.150	6.337	.199	.033	.041	.124	8184
				B		40.307	50.995	8.698	.273	.045	.057	.171	11234
				C		44.147	55.853		.299	.050	.062	.187	12304
SH-4 7S R44E S26 DBAA	94 to 104 ft.	13	Anderson	A	29.220	21.887	44.925	3.968	.147	.016	.000	.131	8056
				B		30.923	63.472	5.606	.208	.023	.000	.185	11382
				C		32.759	67.241		.220	.024	.000	.196	12058
	104 to 112 ft.	14		A	27.470	30.085	38.760	3.685	.154	.009	.000	.145	8174
				B		41.479	53.440	5.081	.212	.012	.000	.200	11270
				C		43.700	56.300		.223	.012	.000	.211	11873
	112 to 120 ft.	15		A	26.360	35.710	34.574	3.356	.128	.009	.000	.120	8583
				B		48.493	46.950	4.557	.174	.012	.000	.162	11656
				C		50.808	49.192		.182	.012	.000	.170	12212
SH-9 7S R44E S33 BDCA	113 to 123 ft.	19	Anderson	A	27.700	32.308	36.617	3.375	.197	.033	.033	.131	8403
				B		44.686	50.646	4.668	.272	.045	.045	.181	11622
				C		46.874	53.126		.285	.048	.048	.190	12192
	123 to 131 ft.	20		A	22.850	30.042	28.686	18.422	2.132	.846	.613	.673	6751
				B		38.939	37.182	23.878	2.764	1.097	.794	.873	8750
				C		51.154	48.846		3.631	1.441	1.044	1.147	11495
SH-10 7S R44E S31 ACCD	130 to 140 ft.	21	Anderson	A	25.550	31.537	38.151	4.761	.330	.059	.068	.203	8780
				B		42.361	51.244	6.396	.443	.080	.091	.273	11794
				C		45.255	54.745		.473	.085	.097	.291	12600
	140 to 149 ft.	22		A	27.440	30.586	37.705	4.270	.311	.042	.092	.177	8418
				B		42.152	51.963	5.884	.429	.058	.127	.243	11601
				C		44.788	55.212		.455	.062	.135	.258	12326

SH-10 7S R44E S31 ACCD	149 to 157 ft.	23	Anderson	A	28.300	30.878	36.017	4.806	.310	.057	.073	.179	8266
				B		43.065	50.233	6.702	.432	.080	.102	.250	11529
				C		46.159	53.841		.463	.085	.110	.268	12357
	157 to 158 ft.	24		A	20.320	30.878	36.017	4.806	.310	.057	.073	.179	8266
				B		43.065	50.233	6.702	.432	.080	.102	.250	11529
				C		46.159	53.841		.463	.085	.110	.268	12357
SH-11 8S R43E S10 CACC	134 to 144 ft.	25	Anderson	A	28.960	30.440	37.398	3.202	.196	.024	.024	.147	8379
				B		42.849	52.644	4.507	.275	.034	.034	.206	11795
				C		44.871	55.129		.288	.036	.036	.216	12352
SH-13 8S R44E S19 DBAC	88 to 96 ft.	26	Anderson	A	25.550	32.810	38.548	3.092	.211	.008	.000	.202	8896
				B		44.070	51.777	4.153	.283	.011	.000	.272	11949
				C		45.979	54.021		.295	.012	.000	.283	12467
	96 to 102 ft.	27		A	28.530	29.500	38.588	3.382	.097	.000	.000	.097	8506
				B		41.276	53.992	4.732	.136	.000	.000	.136	11902
				C		43.326	56.674		.142	.000	.000	.142	12493
SH-14 8S R44E S30 BCCB	160 to 167 ft.	28	Anderson	A	27.540	25.919	43.016	3.524	.065	.000	.000	.065	8595
				B		35.771	59.366	4.863	.090	.000	.000	.090	11862
				C		37.599	62.401		.095	.000	.000	.095	12468
SH-15 9S R43E S2 BBAA	104 to 113 ft.	29	Anderson	A	27.300	30.446	38.752	3.502	.106	.008	.000	.098	8615
				B		41.880	53.303	4.817	.146	.011	.000	.135	11850
				C		43.999	56.001		.154	.012	.000	.142	12450
	113 to 123 ft.	30		A	26.380	29.739	40.175	3.706	.174	.025	.017	.133	8788
				B		40.395	54.571	5.034	.237	.034	.023	.181	11937
				C		42.536	57.464		.250	.036	.024	.190	12570
	123 to 128 ft.	31		A	23.360	30.283	38.415	7.942	.371	.060	.069	.241	8597
				B		39.514	50.124	10.362	.484	.079	.090	.315	11217
				C		44.082	55.918		.540	.088	.100	.351	12514
SH-16 9S R44E S7 BACC	63 to 70 ft.	32	Anderson	A	26.530	29.719	39.972	3.778	.225	.042	.058	.125	8726
				B		40.451	54.406	5.143	.306	.057	.079	.170	11877
				C		42.644	57.356		.322	.060	.084	.179	12521
	70 to 79 ft.	33		A	24.980	31.900	33.982	9.139	.549	.057	.090	.402	8290
				B		42.522	45.297	12.182	.732	.076	.120	.535	11050
				C		48.420	51.580		.834	.087	.137	.610	12583
SH-17 9S R44E S8 CBBA	180 to 188 ft.	35	Anderson	A	25.690	33.144	36.697	4.469	.202	.008	.034	.160	8835
				B		44.603	49.384	6.013	.271	.011	.045	.215	11890
				C		47.456	52.544		.289	.012	.048	.229	12651
	188 to 197 ft.	36		A	25.630	30.252	40.491	3.627	.093	.008	.000	.084	8777
				B		40.678	54.445	4.876	.125	.011	.000	.113	11802
				C		42.763	57.237		.131	.012	.000	.119	12407
	197 to 200 ft.	37		A	24.330	29.712	32.771	13.187	1.034	.118	.706	.210	7863
				B		39.265	43.308	17.428	1.366	.156	.933	.278	10391
				C		47.522	52.448		1.655	.188	1.130	.336	12584
SH-18 9S R44E S22 CCAD	63 to 72 ft.	38	Anderson	A	28.540	30.561	36.249	4.650	.219	.041	.065	.114	8258
				B		42.766	50.727	6.507	.307	.057	.091	.159	11556
				C		45.743	54.257		.328	.061	.097	.170	12360

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 26 (Continued).

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-18 9S R44E S22 CCAD	72 to 80 ft.	39	Anderson	A	27.630	33.369	34.956	4.046	.247	.041	.025	.181	8245
				B		46.108	48.301	5.590	.341	.057	.034	.250	11393
				C		48.839	51.161		.361	.060	.036	.263	12068
	80 to 83 ft.	40		A	27.220	29.929	38.941	3.911	.231	.050	.033	.149	8438
				B		41.122	53.504	5.373	.318	.068	.045	.204	11594
				C		43.457	56.543		.336	.072	.048	.216	12252
	151 to 156 ft.	41	Dietz	A	25.830	29.854	34.329	9.987	.477	.000	.033	.444	7722
				B		40.251	46.284	13.465	.643	.000	.044	.599	10411
				C		46.514	53.486		.743	.000	.051	.692	12032
SH-19 9S R44E S19 DDDC	74 to 84 ft.	42	Anderson	A	24.160	30.905	39.151	5.784	.170	.034	.034	.102	8390
				B		40.750	51.623	7.627	.225	.045	.045	.135	11063
				C		44.115	55.885		.243	.049	.049	.146	11976
	84 to 92 ft.	43		A	23.830	31.525	40.401	4.244	.284	.026	.095	.164	8802
				B		41.388	53.040	5.572	.373	.034	.124	.215	11555
				C		43.830	56.170		.395	.036	.132	.227	12237
	92 to 100 ft.	44		A	26.640	29.497	40.425	3.438	.191	.025	.066	.100	8306
				B		40.208	55.105	4.686	.260	.034	.091	.136	11322
				C		42.185	57.815		.273	.036	.095	.143	11879
SH-20 9S R43E S24 AACA	110 to 119 ft.	45	Anderson	A	25.850	29.469	41.647	3.034	.141	.000	.000	.141	8893
				B		39.742	56.166	4.092	.191	.000	.000	.191	11993
				C		41.438	58.562		.199	.000	.000	.199	12505
	119 to 124 ft.	46		A	21.460	32.017	30.531	15.991	.242	.000	.026	.216	7573
				B		40.766	38.874	20.361	.308	.000	.033	.275	9643
				C		51.188	48.812		.387	.000	.041	.345	12108
	124 to 129 ft.	47		A	25.280	29.812	41.653	3.255	.143	.000	.000	.143	8840
				B		39.899	55.746	4.356	.191	.000	.000	.191	11831
				C		41.716	58.284		.200	.000	.000	.200	12370
SH-21 9S R43E S11 DCAC	63 to 73 ft.	48	Anderson	A	26.130	29.702	40.778	3.390	.109	.034	.017	.059	8901
				B		40.209	55.202	4.589	.148	.045	.023	.080	12050
				C		42.143	57.857		.155	.048	.024	.083	12630
	73 to 80 ft.	49		A	26.100	28.753	38.709	6.437	.430	.160	.110	.160	8135
				B		38.909	52.380	8.711	.582	.217	.148	.217	11008
				C		42.621	57.379		.638	.238	.163	.238	12059
	80 to 85 ft.	50		A	27.510	28.176	39.417	4.897	.123	.025	.008	.090	8445
				B		38.869	54.375	6.756	.170	.034	.011	.125	11650
				C		41.685	58.315		.182	.036	.012	.134	12495
SH-22 9S R43E S4 DBDD	93 to 98 ft.	51	Anderson	A	26.190	29.039	40.146	4.625	.075	.000	.000	.075	8521
				B		39.343	54.391	6.266	.102	.000	.000	.102	11544
				C		41.973	58.027		.109	.000	.000	.109	12316
SH-23 9S R43E S22 DBDD	130 to 140 ft.	54	Anderson	A	24.540	29.824	41.474	4.162	.196	.017	.017	.162	8685
				B		39.523	54.962	5.515	.260	.023	.023	.215	11510
				C		41.830	58.170		.275	.024	.024	.227	12182
SH-24 9S R43E S35 BCAC	95 to 101 ft.	55	Smith	A	23.710	28.182	36.014	12.094	.787	.052	.199	.536	7877
				B		36.941	47.207	15.853	1.031	.068	.261	.703	10325
				C		43.900	56.100		1.225	.081	.310	.835	12270
SH-26 9S R43E S6 CCDB	114 to 124 ft.	64	Anderson	A	26.490	28.547	41.456	3.507	.166	.000	.041	.124	8744
				B		38.834	56.395	4.771	.226	.000	.056	.169	11895
				C		40.779	59.221		.237	.000	.059	.178	12491

SH-26 9S 43E S6 CCDB	124 to 132 ft.	65	Anderson	A	25.580	31.117	39.585	3.718	.313	.025	.059	.228	8700
				B		41.812	53.191	4.997	.420	.034	.079	.307	11690
				C		44.011	55.989		.442	.036	.084	.323	12303
	132 to 135 ft.	66		A	26.670	29.842	39.492	3.996	.230	.000	.049	.181	8733
				B		40.696	53.855	5.449	.313	.000	.067	.246	11909
				C		43.041	56.939		.331	.000	.071	.260	12595
SH-27 8S 43E S31 CABB	137 to 145 ft.	67	Anderson	A	25.520	29.643	40.194	4.643	.134	.000	.025	.109	8665
				B		39.800	53.966	6.234	.180	.000	.034	.146	11634
				C		42.446	57.554		.192	.000	.036	.156	12407
	145 to 155 ft.	68		A	24.140	30.280	37.089	8.492	.191	.000	.043	.147	8847
				B		39.915	48.891	11.194	.252	.000	.057	.194	11662
				C		44.947	55.053		.283	.000	.064	.219	13132
	155 to 162 ft.	69		A	25.010	28.030	43.701	3.259	.180	.000	.026	.154	9000
				B		37.379	58.275	4.346	.240	.000	.034	.205	12002
				C		39.077	60.923		.250	.000	.036	.215	12547
SH-28 8S 42E S24 DBAA	93 to 102 ft.	70	Anderson	A	25.940	31.622	39.131	3.308	.130	.000	.016	.114	8235
				B		42.697	52.837	4.466	.176	.000	.022	.154	11119
				C		44.693	55.307		.184	.000	.023	.161	11639
SH-29 8S 42E S12 CBDD	89 to 97 ft.	71	Anderson	A	26.460	29.503	40.004	4.033	.134	.000	.017	.117	8583
				B		40.118	54.398	5.484	.182	.000	.023	.159	11671
				C		42.446	57.554		.193	.000	.024	.169	12349
	97 to 106 ft.	72		A	24.810	30.220	41.504	3.466	.189	.000	.026	.163	8804
				B		40.192	55.198	4.609	.252	.000	.034	.217	11709
				C		42.134	57.866		.264	.000	.036	.228	12275
	106 to 115 ft.	73		A	25.180	30.544	40.953	3.323	.327	.000	.060	.267	8676
				B		40.824	54.735	4.441	.437	.000	.081	.357	11596
				C		42.721	57.279		.458	.000	.084	.373	12135
SH-57 7S 44E S28 BACC	110 to 118 ft.	56	Canyon	A	23.740	31.258	36.546	8.456	.612	.067	.168	.377	8108
				B		40.989	47.923	11.088	.802	.088	.220	.495	10632
				C		46.101	53.899		.902	.099	.247	.556	11958
	118 to 126 ft.	57		A	24.620	30.778	40.950	3.652	.219	.034	.067	.118	8866
				B		40.830	54.325	4.845	.291	.045	.090	.157	11762
				C		42.909	57.091		.306	.047	.094	.165	12361
SH-118 8S 44E S2 DBCA	53 to 62 ft.	4	Dietz	A	23.890	31.205	40.822	4.083	.268	.026	.035	.207	8707
				B		40.000	53.635	5.365	.352	.034	.045	.272	11440
				C		43.325	56.675		.372	.036	.048	.288	12089
	62 to 65 ft.	5		A	28.170	31.519	36.630	3.681	.297	.016	.024	.257	7972
				B		43.880	50.996	5.124	.414	.022	.034	.358	11099
				C		46.250	53.750		.436	.024	.035	.377	11698
SH-119 9S 43E S15 CBCA	110 to 119 ft.	52	Anderson	A	27.130	29.418	40.379	3.073	.148	.000	.000	.148	8657
				B		40.370	55.413	4.217	.203	.000	.000	.203	11880
				C		42.147	57.853		.212	.000	.000	.212	12403
	119 to 127 ft.	53		A	24.230	29.688	42.045	4.036	.307	.026	.060	.222	9012
				B		39.182	55.490	5.327	.405	.034	.079	.293	11894
				C		41.387	58.613		.428	.036	.083	.309	12564
SH-7039 7S 44E S19 CCAB	46 to 60 ft.	217	Canyon	A	23.080	30.858	42.111	3.952	.258	.017	.077	.164	9081
				B		40.116	54.746	5.138	.336	.022	.101	.213	11805
				C		42.289	57.711		.354	.024	.106	.224	12445
	60 to 70 ft.	218		A	29.180	26.866	34.562	9.392	.540	.023	.200	.316	7657
				B		37.936	48.802	13.262	.762	.033	.283	.446	10812
				C		43.736	56.264		.879	.038	.326	.515	12465
SH-7040 7S 44E S27 BBAA	63 to 67 ft.	219	Dietz	A	31.800	28.459	35.463	4.278	.304	.007	.163	.134	7911
				B		41.729	51.998	6.272	.446	.011	.240	.196	11600
				C		44.522	55.478		.476	.012	.256	.209	12376

[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 27.—Major ash constituents, Hanging Woman Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-1 8S 45E S7 CAAD	100 to 118 ft.	2-3	Anderson	14.8	26.9	4.7	.3	7.7	13.8	.5	20.0	12.0	1.0	101.7
SH-2 8S 44E S12 BCCC	83 to 112 ft.	6-9	Anderson	14.9	27.8	5.8	.3	9.2	7.3	.9	17.4	16.4	.7	100.7
SH-3 8S 44E S3 DCCA	88 to 116 ft.	10-12	Anderson	14.7	21.9	4.7	.8	6.5	16.0	.7	31.9	10.3	1.1	108.6
SH-4 7S 44E S26 DBAA	94 to 120 ft.	13-15	Anderson	14.6	27.4	5.5	.8	7.2	15.8	.5	19.7	10.1	.9	102.5
SH-9 7S 44E S33 BDCA	113 to 131 ft.	19-20	Anderson	13.3	13.3	12.1	.7	4.8	3.5	.7	21.9	24.1	.7	95.1
SH-10 7S 44E S31 ACCD	130 to 158 ft.	21-24	Anderson	14.1	20.1	5.5	.3	6.0	13.9	.6	24.3	15.3	1.3	101.4
SH-11 8S 43E S10 CACC	134 to 144 ft.	25	Anderson		22.5		.4	6.4	12.2			13.9		
SH-13 8S 44E S19 DBAC	88 to 102 ft.	26-27	Anderson	18.5	23.6	5.7	.3	6.4	12.5	.4	17.6	10.1	1.2	96.3
SH-14 8S 44E S30 BCCB	160 to 167 ft.	28	Anderson	17.9	19.8	5.8	.7	5.6	9.7	.3	27.5	9.0	1.9	98.2
SH-15 9S 43E S2 BBAA	104 to 128 ft.	29-31	Anderson	18.3	12.0	5.4	1.1	3.5	6.6	.9	41.8	9.7	1.4	100.7
SH-16 9S 44E S7 BACC	63 to 83 ft.	32-34	Anderson	17.9	7.6	10.4	1.1	2.6	5.0	.4	41.7	12.0	1.0	99.7
SH-17 9S 44E S8 CBBA	180 to 200 ft.	35-37	Anderson	19.6	17.5	8.3	.3	4.2	7.3	.9	22.0	22.2	.9	103.2
SH-18 9S 44E S22 CCAD	63 to 83 ft.	38-40	Anderson	14.4	21.6	6.6	.2	8.4	4.0	1.2	23.6	15.8	1.5	97.3
SH-19 9S 44E S19 DDDC	74 to 100 ft.	42-44	Anderson	14.6	21.2	5.0	.2	7.4	6.7	1.1	25.6	15.2	1.6	98.6

SH-20 9S 43E S24 AACA	110 to 129 ft.	45-47	Anderson	14.6	20.3	9.0	.3	4.9	10.3	1.0	19.3	14.2	1.2	95.1
SH-21 9S 43E S11 DCAC	63 to 85 ft.	48-50	Anderson	15.4	19.2	8.8	.4	5.3	10.3	1.1	21.1	12.9	1.5	96.0
SH-22 9S 43E S4 DBDD	93 to 98 ft.	51	Anderson	11.1	17.5	15.9	.2	5.7	7.1	.3	19.4	7.7	.5	85.4
SH-23 9S 43E S22 DBDD	130 to 140 ft.	54	Anderson	15.6	23.4	5.1	.3	6.7	8.3	.3	21.2	10.3	2.4	93.6
SH-24 9S 43E S35 BCAC	95 to 101 ft.	55	Smith	12.8	7.1	12.1	1.6	7.2	2.6	.8	37.1	9.1	.4	90.8
SH-26 9S 43E S6 CCDB	114 to 135 ft.	64-66	Anderson	15.6	19.8	5.0	.3	6.2	5.9	.7	23.4	13.9	1.3	92.1
SH-27 8S 43E S31 CABB	137 to 162 ft.	67-69	Anderson	14.3	19.6	4.9	.2	4.5	10.8	.6	25.1	9.8	1.3	91.1
SH-28 8S 42E S24 DBAA	93 to 102 ft.	70	Anderson	16.4	21.9	5.7	.4	5.4	11.4	.6	24.1	13.7	1.1	100.7
SH-29 8S 42E S12 CBDD	89 to 115 ft.	71-73	Anderson	14.7	19.7	4.6	.4	5.0	11.3	.5	20.4	12.9	1.0	90.5
SH-57 7S 44E S28 BACC	110 to 126 ft.	56-57	Canyon	15.1	16.9	3.6	.5	4.5	14.1	.9	27.7	14.8	.7	98.8
SH-118 8S 44E S2 DBCA	53 to 65 ft.	4-5	Dietz	12.8	23.2	5.1	.3	6.1	12.9	1.0	20.4	14.0	.8	96.6
SH-119 9S 43E S15 CBCA	110 to 127 ft.	52-53	Anderson	16.9	20.2	7.9	.2	4.9	9.5	.7	18.0	15.0	.7	94.0
SH-7039 7S 44E S19 CCAB	46 to 70 ft.	217-218	Canyon	13.9	15.6	4.8	1.8	7.7	1.6	.1	42.1	11.6	.6	99.8

coal on its school-grant lands; a small amount of coal in the area is privately owned.

SURFACE FEATURES AND LAND USE

The most prominent surface features in the Hanging Woman Creek coal deposit are the creek and its tributaries. Hanging Woman Creek is an intermittent stream, which contains water in pools throughout the year, but the tributaries are dry except during periods of heavy precipitation and spring runoff. The rolling uplands are deeply dissected by the tributaries of Hanging Woman Creek, and the terrain is especially rugged in T. 7 and 8 S., R. 43 E. Stands of ponderosa pine are sparse along the steep sides of the valleys; native grasses cover the ridges.

The principal land use is livestock grazing, but some hay is raised in meadows along the flood plain of Hanging Woman Creek and a few of its tributaries.

GEOLOGIC STRUCTURE

The Anderson coal bed dips to the south, and minor reversals seem to have affected the topography. Slight synclinal flexures along Hanging Woman Creek and the divide to the east plunge gently southward.

Displacement on two northeast-trending faults downthrown to the southeast seemingly is less than 100 feet. The faults may extend farther than shown, particularly between drill hole SH-23 in sec. 26, T. 9 S., R. 43 E., and drill hole SH-24 in sec. 35 of that township. An east-trending fault is along PK Creek, in T. 8 S., R. 42 and 43 E., downthrown on the north.

COAL BEDS

The names applied to the coal beds in the Hanging Woman Creek coal field are those used by Baker (1929). They include the Roland, Smith, Anderson, Dietz, and the Canyon beds. Several other coal beds lie below the Canyon bed. A complete stratigraphic section (Pl. 33, Section D-M) is shown on the gamma log of an oil well in NE¼ sec. 36, T. 9 S., R. 42 E. This log shows the Roland bed as 9 feet thick and 291 feet above the Smith bed, which is 8 feet thick. The Smith bed is 148 feet above the Anderson bed, which is 31 feet thick; the Anderson bed is 122 feet above the Dietz No. 1 bed and 145 feet above the Dietz No. 2 bed, each of which is only 4 feet thick. Three coal beds about 230 feet below the Anderson bed have thicknesses of 6 feet, 3 feet, and 8 feet, and are separated by 10-foot partings. The Canyon coal bed is 13 feet thick and is about 300 feet below the Anderson. The Wall coal bed, 140 feet below the top of the Canyon coal bed, consists of three benches. The top one is 9 feet thick, the middle one 6 feet, and the lower one 4 feet. The upper parting is 6 feet and the lower is 16 feet. This log correlates well with the gamma logs of an oil well in SW¼ sec. 17, T. 9 S., R. 44 E.

The Anderson coal bed is burned over much of the area, especially where overburden is less than 50 feet thick (Pl. 9). Nevertheless, it is the most important bed in the Hanging Woman Creek area because it maintains its thickness and consistent quality. Subsurface correlation of the Anderson bed is relatively easy because of its thickness and its distinctive curve on bore-hole geophysical logs. The thickness ranges from 15 feet in drill hole SH-23, sec. 22, T. 9 S., R. 43 E., to 36 feet in drill hole SH-3, sec. 3, T. 8 S., R. 44 E.

The Dietz coal bed (Pl. 9) crops out along the sides of the valleys of Hanging Woman Creek and its tributaries in the northern part of the area. In places, the bed has burned and produced clinker, especially in the northern part of the area where the bed is thickest. The maximum thickness of 18 feet was penetrated in drill hole SH-10, sec. 31, T. 7 S., R. 44 E.; in drill hole SH-18 in sec. 22, T. 9 S., R. 44 E., it has a thickness of 10 feet. In the southwestern part of the area, the Dietz bed consists of two benches, each 4 feet thick, separated by as much as 30 feet of parting.

Strippable reserves in the Dietz coal bed over large areas are covered with clinker produced by burning of the overlying Anderson coal bed. The vertical distance between the Dietz and the Anderson bed (Pl. 9) is 50 to 70 feet in a large part of the area. Although it is 70 feet in a large part of T. 9 S., R. 44 E., it decreases westward to 60 feet, then increases to 100 feet in T. 9 S., R. 42 E. This is the area where the Dietz coal bed splits and thins appreciably. In most places where the Anderson bed has not burned, it is about 100 feet above the Dietz bed. For this reason, strippable reserves in the Dietz bed have been shown as far as the trace of the unburned Anderson coal bed. In certain areas, such as the East Fork and Main Fork of Trail Creek, the Dietz coal bed could be recovered economically as far back as the Anderson overburden limit of 50 feet. Information on the Dietz bed is not as plentiful as for the Anderson bed. One or more silicified layers about 2 to 4 feet thick hampered drilling between the Anderson and the Dietz coal beds. Also, very heavy white clay encountered in drill hole SH-23, sec. 22, T. 9 S., R. 43 E., tended to plug the drill pipe.

COAL QUALITY

Several core samples were obtained from the Hanging Woman Creek coal field and were analyzed. Proximate analysis, forms of sulfur, and heating values are shown in Table 26. Where multiple core samples were obtained from a coal bed in a drill hole, they were combined prior to analysis for major ash constituents (Table 27).

COAL RESERVES

Coal reserves in the Hanging Woman Creek area have been calculated for both the Anderson and Dietz coal beds (Table 25).

Reserves in the Anderson coal bed total 1,583,290,000 tons, and in the Dietz coal bed, 1,120,960,000 tons.

WEST MOORHEAD COAL DEPOSIT

LOCATION

The West Moorhead coal field, in T. 7 S., R. 46 and 47 E., T. 8 S., R. 45, 46, and 47 E., and the north half of T. 9 S., R. 45, 46, and 47 E., Powder River County (Pl. 10A, B, and C), is limited on the east by the steep slope of the Powder River valley, on the south and west by high ridges, and on the north by clinker areas of the burned Anderson and Canyon coal beds. The area borders the Hanging Woman Creek coal field (Pl. 9) to the west and the Diamond Butte (Pl. 19), Goodspeed Butte (Pl. 20), and Fire Gulch (Pl. 21) coal fields to the north.

FIELD WORK AND MAP PREPARATION

Most of the field work for this report was done during the summer of 1968, but in 1969 and 1970 some additional holes were drilled. The field method used for evaluation of strippable coal in the West Moorhead coal field was developed for areas where adequate topographic maps were not available (Carmichael, 1967). It included the establishment of temporary benchmarks by leveling throughout the area for topographic control. These benchmarks then served as base stations for altimeter surveys by which hundreds of altimeter altitudes were measured and plotted on aerial photos concurrently with mapping of the coal outcrops, clinker, and contacts between the burned and unburned areas. Drilling was carried out on a reconnaissance basis to determine coal thickness and depth; cores were taken for analysis of coal quality.

Modifications of the method by Montana Bureau of Mines and Geology included use of a Paulin microbarograph for recording variations in atmospheric pressure, and use of a computer program to correct altimeter readings for changes in temperature and pressure.

PREVIOUS GEOLOGIC WORK

The West Moorhead coal field was described in an open-file report by the U.S. Geological Survey (Bryson and Bass, 1966), and in a Montana Bureau of Mines and Geology bulletin (Matson, 1971).

LAND OWNERSHIP

Sec. 16 and 36 of each township were granted to the State of Montana for school land, and the state has generally retained the mineral rights. In the other sections of each township, the Federal Government generally retained the coal rights and some of the other mineral rights, but most of the surface is privately owned.

SURFACE FEATURES AND LAND USE

The topography is characterized by long smooth ridge tops, sharp breaks along the slopes of the ridges, and the deeply incised valleys of tributaries of Otter Creek.

Although a small part of the area is cultivated and some hay is raised in many of the valleys, most of the area is suitable only for livestock grazing. Ponderosa pine thinly veils much of the northern part of the area, especially along the steep sides of the valleys.

GEOLOGIC STRUCTURE

The regional dip of the strata is southwestward, but reversals are numerous in shallow anticlinal and synclinal structures.

Two west-trending faults were mapped by Bryson and Bass (1966), one in the northern part of sec. 13, T. 8 S., R. 46 E., and sec. 18, T. 8 S., R. 47 E., and another in the north-central part of T. 8 S., R. 45 E. The maximum relative vertical displacement observed on the Anderson coal bed in sec. 13, T. 8 S., R. 46 E., is about 60 feet. Displacement of the Anderson coal bed by the fault in T. 8 S., R. 45 E., is about 40 feet.

The dominant structural features are shallow anticlines and synclines in the eastern two-thirds of the mapped area, where dips are about 1 degree (Pl. 10A and C). A pronounced structural high in sec. 17, 18, 20, and 21, T. 8 S., R. 47 E., is south of the west-trending faults in that township.

The structural contours on the Canyon and Anderson beds show the variation in the stratigraphic separation of these two coal beds. The vertical distance between these coal beds is at a minimum, 120 feet, in the southern part

Table 28.—Reserves, overburden, overburden ratio, acres, and tons/acre, West Moorhead coal deposit.

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
ANDERSON, DIETZ, and CANYON BEDS					
0 to 50	317.77	725.95	2.28	13,632.0	23,310.6
50 to 100	991.41	3,594.12	3.62	29,702.4	33,378.6
100 to 150	662.24	3,899.28	5.88	19,289.6	34,331.4
	Total 1,971.42	Total 8,219.35	Average 4.16	Total 62,624.0	Average 31,480.2
ANDERSON BED					
0 to 50	65.95	76.5	1.15	1,433.6	46,003.1
50 to 100	466.62	1,268.6	2.71	10,483.2	44,512.1
100 to 150	351.17	1,571.3	4.47	7,744.0	45,347.4
	Total 883.74	Total 2,916.4	Average 3.30	Total 19,660.8	Average 44,949.3
DIETZ BED					
0 to 50	217.81	595.61	2.73	11,187.2	19,469.5
50 to 100	179.68	1,116.68	6.21	9,228.8	19,469.4
	Total 397.49	Total 1,712.29	Average 4.30	Total 20,416.0	Average 19,469.5
CANYON BED					
0 to 50	34.01	53.84	1.58	1,011.2	33,633.3
50 to 100	345.11	1,208.84	3.50	9,990.4	34,544.2
100 to 150	311.07	2,327.98	7.48	11,545.6	26,942.7
	Total 690.19	Total 3,590.66	Average 5.2	Total 22,547.2	Average 30,611.1

of T. 8 S., R. 47 E. It increases westward to the maximum of 240 feet and increases northward to about 200 feet.

COAL BEDS

Although coal beds are numerous in the mapped area, only the Canyon, Dietz, and Anderson beds offer prospects for commercial development. These beds correlate with beds of the same name in the Hanging Woman Creek area (Pl. 33, Section D-M). Other coal beds in the area include the Smith bed, which is 110 to 150 feet above the Anderson coal bed, and the Roland bed. The Smith bed is thin, and in the western part of the mapped area it contains numerous petrified tree stumps, many of which are in an upright position. The Roland coal bed, mapped just south of the study area, is about 200 feet above the Smith bed (Bryson and Bass, 1966).

The Anderson coal bed (Pl. 10A) is 40 to 81 feet above the Dietz bed except in sec. 27, T. 8 S., R. 47 E., where in drill hole SM-4C the distance from the base of the Anderson to the top of the Dietz is only 13 feet. This is also the area where the distance between the Anderson and the Canyon beds reaches its minimum of 120 feet. Thickness of the Anderson bed exceeds 24 feet except in the extreme south-central part of the mapped area (Pl. 10A). At the western edge of the area, the Anderson bed is 30 feet thick in drill hole SM-19, sec. 33, T. 8 S., R. 45 E. In the eastern part of the area, it is 29 feet thick in drill hole SM-4, sec. 27, T. 8 S., R. 47 E. The area of thinning is believed to be confined to the vicinity of sec. 16, T. 9 S., R. 46 E., where the coal is 14 feet thick in drill hole SM-15. Whereas only 1½ miles northeast in drill hole SM-11, sec. 11, T. 9 S., R. 46 E., the bed is 29 feet thick.

Table 29.—Proximate analysis, forms of sulfur, and heating value, West Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-61 7S R46E S33 BDAC	125 to 134 ft.	134	Canyon	A	26.660	31.323	36.509	5.507	.295	.017	.104	.174	8379
				B		42.710	49.781	7.509	.403	.024	.142	.237	11425
				C		46.177	53.823		.435	.026	.154	.256	12352
	134 to 143 ft.	135		A	26.990	30.383	37.843	4.784	.323	.034	.076	.212	8281
				B		41.615	51.833	6.552	.442	.047	.105	.291	11343
				C		44.533	55.467		.473	.050	.112	.311	12138
	143 to 147 ft.	136		A	26.450	29.305	34.258	9.988	1.383	.049	.447	.887	7534
				B		39.843	46.577	13.580	1.880	.066	.608	1.205	10243
				C		46.104	53.896		2.175	.077	.704	1.395	11853
SH-62 8S R46E S3 BDBB	78 to 85 ft.	137	Canyon	A	24.230	32.520	37.609	5.640	.245	.035	.061	.149	8462
				B		42.920	49.636	7.444	.324	.046	.081	.197	11169
				C		46.372	53.628		.350	.050	.087	.212	12067
	85 to 89 ft.	138		A	25.670	30.658	36.919	6.753	.415	.043	.052	.320	8029
				B		41.245	49.669	9.086	.558	.058	.070	.430	10802
				C		45.367	54.633		.613	.064	.077	.473	11881
SH-64 7S R46E S10 DCBC	48 to 50 ft.	139	Cook	A	30.800	29.889	36.181	3.130	.151	.024	.040	.087	7948
				B		43.192	52.285	4.524	.218	.034	.057	.126	11486
				C		45.238	54.762		.228	.036	.060	.132	12030
SH-7041 8S R45E S28 DAAD	59 to 68 ft.	220	Dietz	A	31.200	30.887	33.843	4.069	.315	.015	.069	.230	7907
				B		44.895	49.191	5.915	.458	.022	.100	.335	11492
				C		47.717	52.283		.486	.024	.107	.356	12214
	68 to 69 ft.	221		A	30.050	29.442	35.226	5.282	.386	.015	.085	.286	8007
				B		42.091	50.359	7.551	.552	.022	.121	.408	11446
				C		45.528	54.472		.597	.024	.131	.442	12381
	198 to 208 ft.	222	Canyon	A	29.860	29.057	37.338	3.745	.092	.000	.038	.054	7970
				B		41.427	53.233	5.340	.131	.000	.055	.077	11363
				C		43.764	56.236		.139	.000	.058	.081	12004
SH-7042 8S R45E S15 BBDD	130 to 142 ft.	223	Canyon	A	29.980	30.792	36.056	3.172	.138	.000	.031	.107	8241
				B		43.976	51.494	4.530	.197	.000	.044	.153	11769
				C		46.063	53.937		.206	.000	.046	.160	12328
SH-7043 8S R45E S24 BAAA	43 to 52 ft.	228	Dietz	A	32.430	29.544	34.226	3.800	.660	.023	.123	.514	8080
				B		43.724	50.653	5.623	.977	.034	.182	.761	11957
				C		46.329	53.671		1.035	.036	.193	.806	12670
	52 to 55 ft.	225		A	31.650	28.996	35.997	3.357	.311	.023	.062	.225	7966
				B		42.424	52.666	4.911	.455	.034	.091	.330	11655
				C		44.614	55.386		.478	.036	.096	.347	12257
	132 to 140 ft.	226	Canyon	A	32.180	28.067	35.959	3.794	.228	.023	.121	.083	7826
				B		41.385	53.021	5.594	.336	.034	.179	.123	11539
				C		43.837	56.163		.356	.036	.190	.130	12223
	140 to 148 ft.	224		A	33.450	26.576	36.674	3.300	.177	.015	.074	.089	7523
				B		39.933	55.108	4.958	.266	.022	.111	.133	11304
				C		42.017	57.983		.280	.023	.117	.140	11894
	148 to 153 ft.	227		A	31.350	26.486	32.633	9.531	1.247	.022	.423	.802	7419
				B		38.581	47.535	13.884	1.817	.032	.616	1.168	10807
				C		44.802	55.198		2.109	.038	.716	1.356	12549

1/A, as received; B, moisture free; C, moisture and ash free.

Table 30.–Proximate analysis, ultimate analysis, and heating value, West Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Ultimate, %					Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	S	H	C	N	O	
SM-4 8S 47E S27 BCAB	86 to 115 ft.	J-6243	Anderson	A	27.2	31.5	36.2	5.1	0.4	6.4	49.3	0.9	37.9	8150
				B		43.3	49.7	7.0	0.6	4.6	67.7	1.2	18.9	11210
				C		46.6	53.4		0.6	4.9	72.9	1.3	20.3	12060
SM-15 9S 46E S16 BADC	64 to 78 ft.	J-6245	Anderson	A	28.6	29.4	35.3	6.7	0.4	6.4	47.5	1.0	38.0	7950
				B		41.2	49.4	9.4	0.5	4.5	66.6	1.4	17.6	11130
				C		45.5	54.5		0.6	4.9	73.5	1.5	19.5	12280
SM-18 8S 45E S23 CDAC	52 to 83 ft.	J-6246	Anderson	A	22.9	32.5	40.4	4.2	0.3	6.1	52.7	1.1	35.6	8790
				B		42.2	52.4	5.4	0.4	4.6	68.4	1.4	19.8	11410
				C		44.6	55.4		0.4	4.8	72.3	1.5	21.0	12060
SM-1A 7S 47E S16 BDC	80 to 98 ft.	J-6242	Canyon	A	29.7	29.9	36.4	4.0	0.3	6.5	48.4	1.0	39.8	8070
				B		42.6	51.7	5.7	0.4	4.6	68.8	1.4	19.1	11470
				C		45.1	54.9		0.4	4.9	73.0	1.5	20.2	12170
SM-13 8S 46E S16 CDCC	84 to 103 ft.	J-6244	Canyon	A	23.4	32.3	40.4	3.9	0.2	6.1	53.4	1.0	35.4	8920
				B		42.2	52.7	5.1	0.3	4.6	69.8	1.4	18.8	11650
				C		44.4	55.6		0.3	4.9	73.5	1.4	19.9	12280

Table 31.–Grindability, forms of sulfur, and fusibility of ash, West Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Hardgrove grindability	Form of sulfur, %				Fusibility of ash, °F		
						Sulfur	Sulfate	Pyritic	Organic	Initial deformation temp.	Softening temp.	Fluid temp.
SM-4 8S 47E S27 BCAB	86 to 115 ft.	J-6243	Anderson	A	43	.40	.01	.01	.38	2350	2410	2460
				B		.56	.02	.01	.53			
				C		.60	.02	.01	.57			
SM-15 9S 46E S16 BADC	64 to 78 ft.	J-6245	Anderson	A	43	.36	.01	.01	.34	2010	2050	2090
				B		.50	.02	.01	.47			
				C		.55	.02	.01	.52			
SM-18 8S 45E S23 CDAC	52 to 83 ft.	J-6246	Anderson	A	45	.30	.03	.03	.24	2480	2530	2570
				B		.39	.04	.04	.31			
				C		.41	.04	.04	.33			
SM-1A 7S 47E S16 BDC	80 to 98 ft.	J-6242	Canyon	A	39	.31	.01	.03	.27	2400	2450	2500
				B		.38	.00	.00	.38			
				C		.40	.00	.00	.40			
SM-13 8S 46E S16 CDCC	84 to 103 ft.	J-6244	Canyon	A	43	.25	.02	.01	.22	2470	2520	2570
				B		.32	.02	.01	.29			
				C		.33	.02	.01	.30			

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[1] A, as received; B, moisture free; C, moisture and ash free.

Table 32.–Major ash constituents, West Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %														
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	H_2O	FeO	MnO	CO_2	Total
SM-1A 7S 47E S16 BDC	80 to 98 ft.	J-6242	Canyon	12.6	29.2	7.2	.66	8.6	7.9	.77	17.2	14.1	.73	.55	.28	.12	<.05	99.96
SM-4 8S 47E S27 BCAB	86 to 115 ft.	J-6243	Anderson	13.4	25.8	7.5	.28	7.1	5.9	.62	18.9	17.3	1.1	.96	.20	.09	.30	99.45
SM-13 8S 46E S16 CDCC	84 to 103 ft.	J-6244	Canyon	11.2	29.3	6.5	.39	8.3	8.8	.64	16.4	15.7	.65	.69	.08	.09	.60	99.34
SM-15 9S 46E S16 BADC	64 to 78 ft.	J-6245	Anderson	15.5	18.4	3.5	1.3	6.0	2.7	.98	35.7	11.6	.93	.68	1.6	.06	.20	99.15
SM-18 8S 45E S23 CDAC	52 to 83 ft.	J-6246	Anderson	12.2	27.0	5.8	.34	8.4	2.4	1.00	14.4	27.4	.72	.30	.32	.06	.10	100.44
SH-61 7S 46E S33 BDAC	125 to 147 ft.	134-136	Canyon	12.1	15.6	6.8	1.0	5.8	2.2	.3	39.7	11.2	.5					95.2
SH-62 8S 46E S3 BDBB	78 to 89 ft.	137-138	Canyon	11.2	19.3	5.7	1.0	7.3	1.1	.4	40.7	11.9	.6					99.2
SH-7041 8S 45E S28 DAAD	59 to 69 ft.	220-221	Dietz	12.2	27.7	6.3	.3	9.9	3.6	1.9	20.5	15.5	.6					98.5
	198 to 208 ft.	222	Canyon	12.1	24.2	6.3	.4	6.1	10.0	1.3	28.4	8.1	.7					97.6
SH-7042 8S 45E S15 BBDD	130 to 142 ft.	223	Canyon	12.4	32.2	7.1	.3	8.1	9.7	.7	14.9	9.7	.5					95.6
SH-7043 8S 45E S24 BAAA	43 to 55 ft.	225,228	Dietz	12.1	23.5	6.9	.2	10.8	1.6	1.7	13.4	25.7	.4					96.3
	132 to 153 ft.	226, 224,227	Canyon	12.7	19.6	6.9	.8	5.2	9.4	1.0	27.8	18.1	.5					102.0

Thickness of the Canyon coal bed (Pl. 10C) ranges from 17 to 24 feet and averages 18 feet in the eastern two-thirds and 22 feet in the western one-third of the mapped area. A coal bed 2 to 5 feet thick lies about 5 feet above the Canyon in the eastern two-thirds of the area but is absent in the western one-third.

The Dietz coal bed (Pl. 10B), 67 to 122 feet above the Canyon bed and 40 to 81 feet below the Anderson coal bed, ranges in thickness from 5 to 11 feet, but seems to be thinner or absent in T. 7 S., R. 47 E.

COAL QUALITY

Twenty core samples were recovered during drilling programs in 1968, 1969, and 1970. Proximate, ultimate, ash fusibility, sulfur forms, and grindability analyses of five cores obtained in 1968 were performed by the U.S. Bureau of Mines, Pittsburgh Coal Research Center (Tables 30, 31). Proximate analyses of cores obtained in 1969 and 1970 were made in the Montana Bureau of Mines and Geology analytical laboratory (Table 29). Major ash constituents of the core samples obtained in 1968 were determined by the U.S. Geological Survey, Washington, D.C.; those in the cores obtained in 1969 and 1970 were determined by the Montana Bureau of Mines and Geology analytical laboratory (Table 32).

COAL RESERVES

The strippable reserves in the West Moorhead coal field total 1,971,420,000 tons. The Anderson bed contains the largest reserves, 883,740,000 tons, the Canyon contains 690,190,000 tons, and the Dietz 397,490,000 tons.

POKER JIM CREEK-O'DELL CREEK COAL DEPOSIT

LOCATION

The Poker Jim Creek-O'Dell Creek coal deposit is in T. 3 through 6 S., R. 42 through 45 E., Rosebud County (Pl. 11A and B). The north end of the area is 3 miles south of the community of Ashland, and the western boundary of the deposit is the Tongue River. The southern boundary is near Birney, where the overburden becomes excessive, and the eastern boundary is the high divide between the Tongue River and Otter Creek. The area is between the Ashland (Pl. 13A) and Otter Creek (Pl. 12) coal deposits to the north and the Birney coal deposit (Pl. 7) to the south.

FIELD WORK AND MAP PREPARATION

Field work in the Poker Jim Creek-O'Dell Creek coal deposit was begun in 1969; further drilling in 1970 expanded the data base. Geologic mapping on black-and-white aerial photos fixed the boundaries of the clinker produced by burning of the Knobloch coal bed. Private company drill holes and logs of oil wells in the vicinity helped in the preparation of maps of the Knobloch coal bed. A cross section through the area is shown on Plate 34.

PREVIOUS GEOLOGIC WORK

The area was mapped and described in a U.S. Geological Survey report on the Birney-Broadus coal field (Warren, 1959). Ayler, Smith, and Deutman (1969) included the Knobloch deposits in their report on the strippable coal reserves in Montana.

LAND OWNERSHIP

The land surface in the Poker Jim Creek-O'Dell Creek coal deposit is owned by individuals, the State of Montana, and the Federal Government. The administration of the federally-owned land is divided between the U.S. Bureau of Land Management and the U.S. Forest Service. Some strippable coal in the northern part of the area lies within the Custer National Forest (Pl. 11B). The ownership of the coal is divided between the Federal Government, Burlington Northern, Inc., the State of Montana, and some individuals. The railroad owns the coal on the odd-numbered sections outside the Custer National Forest and has, in general, conveyed the surface but retained the coal.

SURFACE FEATURES AND LAND USE

The Tongue River has formed a wide valley in the area, and the strippable coal lies on the east side of the valley. The terrain slopes gently toward the Tongue River and, in the northern part of the area, toward the areas of clinker formed by the burning of the underlying Knobloch coal bed, but the clinker forms steep slopes and cliffs.

Many higher coal beds have burned to form clinker, which caps knobs and borders the high ridges to the east. In the north-central part of the area, O'Dell Creek has cut a valley approximately ½ mile wide. Other tributaries of the Tongue River are generally short and steep. Hanging Woman Creek, at the south end of the area, has also cut a prominent valley.

The principal land use in the area is livestock grazing. Hay is raised on meadows on the flood plain of the Tongue River, along O'Dell Creek, and along Hanging Woman Creek.

Table 33.—Reserves, overburden, overburden ratio, acres, and tons/acre, Poker Jim Creek-O'Dell Creek coal deposit.

KNOBLOCH BED—PLATE 11A

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	110.10	268.17	2.43	3,040	36,217.1
50 to 100	122.71	401.60	3.27	2,566	47,821.5
100 to 150	111.94	438.31	3.91	1,824	61,370.6
150 to 200	28.54	133.88	4.69	460	62,043.5
	Total 373.29	Total 1,241.96	Average 3.32	Total 7,890	Average 47,311.8

KNOBLOCH—PLATE 11B

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	8.66	5.79	0.66	108.8	79,595.6
50 to 100	60.66	92.15	1.51	761.6	79,648.1
100 to 150	194.72	509.98	2.61	2,508.8	77,614.8
150 to 200	198.79	709.66	3.55	2,528.0	78,635.3
200 to 250	101.95	464.64	4.55	1,280.0	79,648.4
	Total 564.78	Total 1,782.22	Average 3.15	Total 7,187.2	Average 78,581.4

GEOLOGIC STRUCTURE

The strata in the Poker Jim Creek-O'Dell Creek area are nearly horizontal, but local dips and rises are numerous. In the northern part of the area, the Knobloch coal bed is some distance above river level, and in the western part of T. 5 S., R. 43 E., it crops out at river level. The middle bench of the Knobloch is approximately 100 feet below surface at Birney.

COAL BEDS

The Knobloch is the only coal bed in the Poker Jim Creek-O'Dell Creek area that is strippable. The King bed is 40 to 200 feet above the Knobloch. Other beds in the divide between Tongue River and Otter Creek are the O'Dell, Pawnee, Wall, Cook, Dunning, Canyon, and Anderson beds, but none of these were mapped for this report. The Knobloch coal bed was named for the Knobloch ranch in sec. 17, T. 5 S., R. 43 E.

The Knobloch coal bed is a single seam along the north end of the Poker Jim Creek-O'Dell Creek area (Pl. 11B), but the center of the area and farther south the Knobloch is split into three benches. In the northern part of the area, the Knobloch is as much as 60 feet thick, as measured in drill hole SH-7055, sec. 6, T. 4 S., R. 45 E. In drill hole SH-7059, sec. 34, T. 3 S., R. 44 E., only 14 feet of the coal was drilled, owing to lost circulation. In drill hole SH-7058, sec. 22, T. 4 S., R. 44 E., the Knobloch is 42 feet thick, but in the southern part of T. 4 S., R. 44 E., (Pl. 11B, 34), the Knobloch begins to split into three benches. In drill hole SH-100, sec. 5, T. 5 S., R. 44 E., the upper and middle benches have a combined thickness of 27 feet, and the lower bench, 50 feet below, has a thickness of 5 feet. The main bed splits again in the northern part of T. 5 S., R. 43 E., to form the upper and middle benches. The upper bench is 7½ feet thick in DH-3, sec. 16, T. 5 S., R. 43 E., and 9 feet thick in drill hole SH-101, sec. 20, T. 5 S., R. 43 E., where it is 29 feet above the middle bench, which is 18 feet thick. In an abandoned mine in the SE¼ sec. 19, T. 5 S., R. 43 E., the upper bench is almost 12 feet thick. The 14-foot parting below it consists of 6 feet of claystone and 8 feet of sandstone overlying the middle bench, which is 20 feet thick. In drill hole SH-117 in sec. 30 of the same township, the upper bench is 8 feet thick and the one below it is 20 feet thick. They are separated by a 41-foot parting. In drill hole SH-103, sec. 7, T. 6 S., R. 43 E., a carbonaceous zone about 52 feet above the main bench is presumed to correlate with the upper bench of the Knobloch. In this drill hole the middle bench is 12 feet thick, and the lower bench is 13

Table 34.--Proximate analysis, forms of sulfur, and heating value, Poker Jim Creek-O'Dell Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7058 4S R44E S22 ABCB	193 to 202 ft.	269	Knobloch	A	25.380	30.906	39.223	4.491	.150	.025	.017	.108	9036
				B		41.418	52.564	6.019	.201	.033	.022	.145	12109
				C		44.070	55.930		.213	.036	.024	.154	12884
SH-7059 3S R44E S34 DBBD	200 to 202 ft.	270	Knobloch	A	26.510	29.863	39.958	3.669	.095	.000	.017	.078	9005
				B		40.635	54.372	4.993	.129	.000	.023	.105	12253
				C		42.771	57.229		.136	.000	.025	.111	12897
SH-100 5S R44E S5 ABAA	125 to 134 ft.	158	Knobloch (U & M)	A	22.500	29.007	43.088	5.406	.201	.017	.035	.148	8380
				B		37.428	55.597	6.975	.259	.022	.045	.191	10813
				C		40.235	59.765		.278	.024	.048	.206	11624
SH-103 6S R43E S7 CDAD	105 to 112 ft.	142	Knobloch (M)	A	21.720	31.308	41.068	5.903	.163	.000	.018	.145	8963
				B		39.995	52.464	7.541	.208	.000	.023	.185	11450
				C		43.257	56.743		.225	.000	.025	.200	12384
SH-117 5S R43E S30 BACD	60 to 66 ft.	153	Knobloch (U)	A	22.560	29.278	43.386	4.776	.594	.080	.177	.337	9135
				B		37.808	56.025	6.168	.767	.103	.229	.435	11797
				C		40.293	59.707		.817	.110	.244	.463	12572
SH-7055 4S R45E S6 DDBA	216 to 218 ft.	265	Knobloch (U & M & L)	A	26.320	29.855	37.444	6.381	.154	.000	.024	.130	8558
				B		40.519	50.820	8.661	.209	.000	.033	.176	11615
				C		44.361	55.639		.229	.000	.036	.193	12717

U = Upper bench of Knobloch
M = Middle bench of Knobloch
L = Lower bench of Knobloch

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[1] A, as received; B, moisture free; C, moisture and ash free.

Table 35.—Major ash constituents, Poker Jim Creek-O'Dell Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7058 4S 44E S22 ABCB	193 to 202 ft.	269	Knobloch	21.0	20.6	4.7	.2	3.7	9.8	.4	29.2	6.5	.6	96.7
SH-7059 3S 44E S34 DBBD	200 to 202 ft.	270	Knobloch	23.5	21.6	4.4	.2	3.9	12.3	.6	25.1	5.3	.4	97.3
SH-100 5S 44E S5 ABAA	125 to 134 ft.	158	Knobloch (U & M)	19.4	15.7	3.5	.2	3.3	10.8	.2	29.8	13.2	.6	96.7
SH-103 6S 43E S7 CDAD	105 to 112 ft.	142	Knobloch (M)	26.5	8.1	2.6	.3	1.5	7.1	1.7	44.6	4.1	.7	97.2
SH-117 5S 43E S30 BACD	60 to 66 ft.	153	Knobloch (U)	14.3	12.8	9.2	1.2	3.2	7.0	.2	25.4	20.0	.5	93.8
SH-7055 4S 45E S6 DDBA	216 to 218 ft.	265	Knobloch (U & M & L)	22.0	15.0	2.7	.2	2.5	6.9	.7	39.8	4.9	.8	95.5

U = Upper bench of Knobloch
M = Middle bench of Knobloch
L = Lower bench of Knobloch

feet thick. These beds can be correlated with beds shown on a log of an oil well in the NW¼ sec. 12, T. 6 S., R. 42 E. (Pl. 33 and 34).

COAL QUALITY

Six core samples of the Knobloch coal bed were analyzed in the Montana Bureau of Mines and Geology analytical laboratory for proximate analysis, forms of sulfur, and heating value (Table 34), and major ash constituents (Table 35).

COAL RESERVES

All strippable reserves in the Poker Jim Creek-O'Dell Creek coal deposit are in the Knobloch coal bed (Table 33). The reserves total 938,070,000 tons, comprising 564,780,000 tons shown on Plate 11B and 373,290,000 tons shown on Plate 11A.

OTTER CREEK COAL DEPOSIT

LOCATION

The Otter Creek coal deposit (Pl. 12) is in T. 4 and 5 S., R. 45 and 46 E., about 12 miles south of Ashland by road. The deposit is limited on the west, south, and east by excessive overburden, and on the north it adjoins the Ashland (Pl. 13A and B) and the Poker Jim Creek-O'Dell Creek (Pl. 11A and B) coal deposits. To the southeast it borders the Diamond Butte (Pl. 19) and Goodspeed Butte (Pl. 20) coal deposits. It overlaps the Yager Butte (Pl. 23A and B) coal deposit to the east.

FIELD WORK AND MAP PREPARATION

The evaluation of strippable coal in the Otter Creek area was begun in 1967 when four holes were drilled on state-owned land (Matson, Dahl, and Blumer, 1968). In 1970 additional holes were drilled to extend the coal reserves and to gather data for structural control to accurately determine the strippable reserves. Gamma logs of several oil wells were helpful in developing the structural picture, as well as for compiling the overburden maps. The geology in the Otter Creek area was mapped during the summer of 1970 on black-and-white aerial photos and during the winter of 1972 on color aerial photos.

PREVIOUS GEOLOGIC WORK

The Otter Creek area was included in a report on the Birney-Broadus area (Warren, 1959); in a report on strippable coal (Ayler, Smith, and Deutman, 1969); and in a report on strippable coal deposits on state lands (Matson, Dahl, and Blumer, 1968).

LAND OWNERSHIP

The surface ownership in the Otter Creek area is divided between private individuals, the State of Montana, and the Federal Government. The State of Montana owns the surface in sec. 16 and 36 of each township, and the Federal Government has control of a few small tracts in the east half of T. 4 S., R. 45 E., and the land within the Custer National Forest. The rest of the surface is privately owned.

The ownership of the coal on state sections remains with the state; that on public lands with the Federal Government. The Otter Creek area is within the land grant to Burlington Northern, Inc., which owns coal on the odd-numbered sections outside the Custer National Forest. The railroad has conveyed most of the surface but has kept the coal rights from its original land grant. Some coal along the Otter Creek valley is privately owned.

SURFACE FEATURES AND LAND USE

The principal surface feature in the area, Otter Creek, is a northward-flowing tributary, which joins the Tongue River at Ashland. Except in unusually dry years, it contains water all year, but it also has periods of no flow each year. The major tributaries of Otter Creek flow only during periods of heavy precipitation and spring runoff. Tributaries entering Otter Creek from the east are long, have gentle gradients, and occupy wide valleys. They head near the top of the divide between Otter Creek and Pumpkin Creek to the east. Tributaries entering Otter Creek from the west are shorter and steeper. Otter Creek has deeply intrenched meanders; its present flood plain is about a half mile wide. Clinker formed by the burning of the underlying Knobloch coal bed borders the flood plain and forms nearly vertical clinker banks in places. A broad terrace, 100 to 150 feet above the present level of Otter Creek, has been deeply dissected in places by the tributaries of Otter Creek.

The principal land use in the area is livestock grazing, but grain and hay are raised in fields and meadows along Otter Creek and its tributaries.

GEOLOGIC STRUCTURE

Elevations obtained from drill data on the top of the Knobloch coal bed clearly show an anticline in the north half of T. 5 S., R. 45 E. At its crest, the strata have been uplifted about 80 feet above their position in the southernmost part of T. 4 S., R. 45 E., and in the northern part of T. 5 S., R. 45 E. The Knobloch bed is exposed about 30 to 40 feet above stream level near the crest of the anti-

Table 36.—Reserves, overburden, overburden ratio, acres, and tons/acre, Otter Creek coal deposit.

KNOBLOCH BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	241.77	275.52	1.13	3,686.4	65,591.4
50 to 100	492.21	953.30	1.93	7,091.2	69,413.3
100 to 150	535.42	1,582.42	2.95	7,352.6	72,820.5
150 to 200	487.51	1,454.34	2.98	4,870.4	100,104.7
200 to 250	318.64	1,141.97	3.58	2,790.4	114,207.9
	Total 2,075.55	Total 5,407.55	Average 2.60	Total 25,791.0	Average 80,475.7

cline (Warren, 1959, p. 566). To the north in sec. 16, T. 4 S., R. 45 E., the Knobloch coal bed crops out near stream level, and to the south, in the south half of sec. 26, T. 5 S., R. 45 E., it dips below stream level. Although the information is inconclusive, because of scarcity of drill data, the changes in thickness of the Knobloch coal bed suggest that the anticline, as a structural feature, controlled to some extent the deposition of the Knobloch bed (Pl. 34, Section OC'-A'). The drill holes do show that the Knobloch bed thins and begins to split on the northern flank of the anticline, and the partings thicken on the southern flank, where the lowest bench of the Knobloch is either thin or missing.

COAL BEDS

The Knobloch coal bed contains the only strippable reserves in the Otter Creek coal deposit. Other coal beds include the King bed, which is 70 to 160 feet above the Knobloch bed in T. 5 S., R. 45 E., and several higher beds, which are exposed along the steep slopes of the ridges on both sides of Otter Creek.

The thickest coal section in the Otter Creek deposit was 66 feet as measured in drill hole SH-7054, sec. 2, T. 4 S., R. 45 E. Southward, the Knobloch bed thins gradually; in drill hole SS-6, sec. 16, T. 4 S., R. 45 E., it has a thickness of 47 feet. The split begins to develop in the Knobloch coal bed in the southern part of T. 4 S., R. 45 E., as shown in a log of an oil well in sec. 24 (Pl. 34, Section OC'-A'), where the upper bench is 46 feet thick and the lower bench is 19 feet thick. Both benches thin southward, as shown by the isopachs (Pl. 12). In the northern part of T. 5 S., R. 45 E., the upper bench of the Knobloch splits again and a bench called the middle bench appears. In about this same place, the lower bench thins and has not been traced farther south.

COAL QUALITY

Core samples from the Otter Creek coal field were analyzed by the Montana Bureau of Mines and Geology analytical laboratory, except for one sample taken in 1967 from drill hole SS-5, which was analyzed by the U.S. Bureau of Mines, Pittsburgh Coal Research Center.

Proximate analysis, forms of sulfur, and heating value are shown in Table 37, and major ash constituents are shown in Table 38.

COAL RESERVES

Strippable reserves in the Knobloch coal bed in the Otter Creek coal field total 2,075,550,000 tons (Table 36).

Table 37.–Proximate analysis, forms of sulfur, and heating value, Otter Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7044 5S R46E S30 DDAD	178 to 187 ft.	233	Knobloch	A	27.690	29.270	37.616	5.423	.157	.000	.008	.149	8515
				B		40.479	52.021	7.500	.218	.000	.011	.206	11776
				C		43.761	56.239		.235	.000	.012	.223	12731
	187 to 197 ft.	234		A	28.470	30.685	36.001	4.844	.205	.000	.008	.197	8399
				B		42.898	50.330	6.772	.286	.000	.011	.275	11742
				C		46.014	53.986		.307	.000	.012	.295	12595
	197 to 199 ft.	235		A	28.940	28.224	38.987	3.849	.190	.000	.016	.175	8457
				B		39.719	54.864	5.417	.268	.000	.022	.246	11901
				C		41.993	58.007		.283	.000	.024	.260	12583
SH-7045 5S R46E S20 CBBD	60 to 65 ft.	238	Knobloch	A	29.390	26.025	33.961	10.624	5.320	.126	4.295	.898	8011
				B		36.857	48.097	15.046	7.534	.179	6.083	1.272	11345
				C		43.385	56.615		8.869	.210	7.161	1.498	13354
	106 to 115 ft.	229		A	36.400	25.739	33.990	3.871	.160	.021	.042	.097	7458
				B		40.471	53.443	6.086	.252	.033	.066	.153	11726
				C		43.094	56.906		.268	.035	.070	.163	12486
	115 to 124 ft.	230		A	29.790	28.268	36.774	5.167	.178	.023	.046	.108	7961
				B		40.263	52.378	7.360	.254	.033	.066	.154	11340
				C		43.461	56.539		.274	.036	.071	.167	12240
	124 to 127 ft.	231		A	24.560	30.464	40.739	4.237	.276	.025	.025	.226	8891
				B		40.382	54.002	5.617	.366	.033	.033	.300	11786
				C		42.785	57.215		.388	.035	.035	.318	12487
SH-7049 5S R46E S2 DCDB	177 to 185 ft.	246	Knobloch	A	26.900	35.300	32.576	5.224	.225	.018	.045	.162	8261
				B		48.290	44.563	7.146	.308	.025	.062	.221	11301
				C		52.007	47.993		.331	.026	.066	.238	12171
	185 to 193 ft.	247		A	29.580	29.938	35.761	4.721	.140	.000	.031	.109	8002
				B		42.514	50.783	6.703	.198	.000	.044	.154	11364
				C		45.568	54.432		.213	.000	.047	.165	12180
	193 to 197 ft.	248		A	31.350	30.795	34.151	3.704	.219	.000	.030	.189	7831
				B		44.858	49.747	5.395	.319	.000	.044	.275	11407
				C		47.416	52.584		.338	.000	.047	.291	12038
SH-7051 4S R46E S33 CBBA	116 to 126 ft.	250	Knobloch	A	28.590	28.559	37.832	5.019	.181	.000	.000	.181	8305
				B		39.993	52.979	7.028	.254	.000	.000	.254	11631
				C		43.016	56.984		.273	.000	.000	.273	12510
	126 to 135 ft.	251		A	30.850	26.986	38.550	3.614	.169	.000	.015	.154	8283
				B		39.026	55.748	5.226	.245	.000	.022	.222	11978
				C		41.178	58.822		.258	.000	.023	.235	12638
SH-7052 5S R45E S27 BDAC	106 to 116 ft.	253	Knobloch	A	28.760	31.015	35.949	4.277	.277	.000	.016	.261	8258
				B		43.535	50.461	6.003	.389	.000	.022	.367	11592
				C		46.316	53.684		.414	.000	.024	.390	12332
	116 to 126 ft.	254		A	31.730	36.569	28.188	3.512	.219	.000	.038	.181	8128
				B		53.566	41.289	5.145	.320	.000	.055	.265	11906
				C		56.471	43.529		.338	.000	.265	.279	12554
SH-7053 4S R45E S4 AAAA	112 to 122 ft.	255	Knobloch	A	28.150	28.810	39.185	3.855	.143	.016	.016	.111	8576
				B		40.097	54.537	5.365	.199	.022	.022	.155	11936
				C		42.371	57.629		.210	.023	.023	.163	12613

					Moisture								
SH-7053 4S R45E S4 AAAA	122 to 132 ft.	256	Knobloch	A	28.530	30.904	36.817	3.748	.149	.016	.047	.086	8699
				B		43.241	51.514	5.245	.208	.022	.066	.121	12171
				C		45.635	54.365		.220	.023	.069	.127	12845
	132 to 140 ft.	257		A	26.670	29.897	40.482	2.952	.129	.000	.016	.113	8812
				B		40.770	55.205	4.025	.175	.000	.022	.154	12017
				C		42.480	57.520		.183	.000	.023	.160	12521
	140 to 148 ft.	258		A	27.290	30.073	37.983	4.654	.166	.000	.047	.119	8823
				B		41.361	52.239	6.401	.228	.000	.065	.163	12134
				C		44.189	55.811		.244	.000	.070	.174	12964
	148 to 156 ft.	259		A	27.010	30.241	37.810	4.939	.152	.000	.040	.112	8694
				B		41.432	51.801	6.767	.208	.000	.055	.153	11912
				C		44.439	55.561		.223	.000	.059	.164	12776
	156 to 165 ft.	260		A	26.720	28.930	38.353	5.998	.175	.000	.024	.151	8543
				B		39.478	52.337	8.185	.239	.000	.033	.207	11659
				C		42.998	57.002		.260	.000	.036	.225	12698
	165 to 171 ft.	261		A	27.140	28.786	37.721	6.353	.388	.016	.024	.348	8496
				B		39.509	51.772	8.719	.533	.022	.033	.478	11661
				C		43.283	56.717		.584	.024	.037	.523	12774
SH-7054 4S R45E S2 DBDC	84 to 94 ft.	262	Knobloch	A	25.490	30.717	39.261	4.532	.142	.025	.000	.117	8962
				B		41.225	52.693	6.082	.191	.034	.000	.157	12028
				C		43.895	56.105		.203	.036	.000	.168	12807
	94 to 100 ft.	263		A	23.960	32.554	39.792	3.695	.168	.025	.000	.143	9314
				B		42.811	52.330	4.859	.221	.033	.000	.188	12249
				C		44.998	55.002		.233	.035	.000	.198	12875
	100 to 106 ft.	264		A	23.740	32.853	39.498	3.909	.149	.000	.017	.132	9301
				B		43.080	51.794	5.126	.195	.000	.022	.173	12197
				C		45.408	54.592		.206	.000	.023	.183	12856
SH-7055 4S R45E S6 DDBA	216 to 218 ft.	265	Knobloch	A	26.320	29.855	37.444	6.381	.154	.000	.024	.130	8558
				B		40.519	50.820	8.661	.209	.000	.033	.176	11615
				C		44.361	55.639		.229	.000	.036	.193	12717
SH-7060 4S R46E S6 DDAC	141 to 149 ft.	271	Knobloch	A	29.190	29.104	37.372	4.334	.120	.000	.000	.120	8454
				B		41.102	52.778	6.120	.169	.000	.000	.169	11939
				C		43.782	56.218		.180	.000	.000	.180	12717
	149 to 153 ft.	272		A	30.720	29.460	36.582	3.237	.126	.000	.024	.103	8373
				B		42.523	52.804	4.673	.182	.000	.034	.148	12086
				C		44.608	55.392		.191	.000	.036	.155	12678
SS-5 4S R45E S36 DADD	56 to 77 ft.	I-73319	Knobloch	A	26.6	29.6	38.6	5.2	.200				8740
				B		40.3	52.6	7.1	.300				11910
				C		43.4	56.6		.300				12810

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 38.—Major ash constituents, Otter Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7044 5S 46E S30 DDAD	178 to 199 ft.	233-235	Knobloch	16.2	20.5	5.3	.5	3.5	7.5	.7	27.9	7.8	.6	90.5
SH-7045 5S 46E S20 CBBD	60 to 65 ft.	238	Knobloch	4.9	5.4	61.5	.5	.8	2.7	.1	11.0	10.3	.1	97.3
	106 to 127 ft.	229-231		12.4	20.4	4.9	.3	7.7	5.3	.5	32.2	10.5	.7	94.9
SH-7049 5S 46E S2 DCDB	177 to 197 ft.	246-248	Knobloch	16.4	23.8	5.0	.3	3.7	9.5	.2	28.6	8.3	.6	96.4
SH-7051 4S 46E S33 CBBA	116 to 135 ft.	250-251	Knobloch	18.1	24.1	5.0	.3	3.7	9.4	.7	30.3	7.2	.7	99.5
SH-7052 5S 45E S27 BDAC	106 to 126 ft.	253-254	Knobloch	18.1	20.1	4.7	.2	3.1	8.9	1.2	29.0	10.8	.6	96.7
SH-7053 4S 45E S4 AAAA	112 to 156 ft.	255-259	Knobloch	20.4	20.6	3.6	.2	3.9	9.4	.4	31.0	6.3	.8	96.6
	156 to 171 ft.	260-261		18.1	12.9	3.2	1.0	2.6	5.9	.2	42.2	9.5	.7	96.3
SH-7054 4S 45E S2 DBDC	84 to 106 ft.	262-264	Knobloch	21.5	24.5	3.4	.2	5.3	5.3	.2	25.7	7.1	.6	93.9
SH-7055 4S 45E S6 DDBA	216 to 218 ft.	265	Knobloch	22.0	15.0	2.7	.2	2.5	6.9	.7	39.8	4.9	.8	95.5
SH-7060 4S 46E S6 DDAC	141 to 153 ft.	271-272	Knobloch	19.6	22.5	3.8	.2	1.9	11.0	.1	30.2	5.9	.7	95.9

Table 39.—Reserves, overburden, overburden ratio, acres, and tons/acre, Ashland coal deposit.

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
KNOBLOCH BED					
0 to 50	89.34	51.99	0.58	928	96,271.6
50 to 100	414.26	535.63	1.29	4,416	93,808.9
100 to 150	758.39	1,617.23	2.13	8,256	91,859.3
150 to 200	866.39	2,579.97	2.98	7,616	113,759.2
200 to 250	567.82	2,159.68	3.80	6,016	94,384.9
	Total 2,696.20	Total 6,944.50	Average 2.58	Total 27,200	Average 99,125.0
A, C, and SAWYER BEDS					
0 to 50	146.04	440.56	3.01	8,275.2	17,647.9
50 to 100	111.99	772.84	6.90	6,387.2	17,533.5
100 to 150	99.46	1,128.97	11.35	5,600.0	17,760.7
	Total 357.49	Total 2,342.37	Average 6.55	Total 20,262.4	Average 17,643.0

ASHLAND COAL DEPOSIT

LOCATION

The Ashland coal deposit is in T. 2 and 3 S., R. 44, 45, and 46 E., Powder River and Rosebud Counties (Pl. 13A, B). The area is bounded on the west by the Tongue River, which is also the east boundary of the Northern Cheyenne Indian Reservation. It is bounded on the east by excessively thick overburden on the divide between Pumpkin Creek and Otter Creek. To the north, the area borders the Beaver Creek-Liscom Creek coal deposit (Pl. 9), and to the south, it borders the Poker Jim Creek-O'Dell Creek coal deposit (Pl. 11B), which is south of the southeastern corner of T. 3 S., R. 44 E., and the Otter Creek coal deposit (Pl. 12), which is south of T. 3 S., R. 45 and 46 E.

FIELD WORK AND MAP PREPARATION

The field work, conducted during the summer of 1970, included drilling and surface mapping of the coal outcrops and clinker boundaries. Black-and-white aerial photos were used for field mapping; colored aerial photos borrowed from the Ashland Division of the U.S. Forest Service were used for further evaluation. Structure contour maps of the top of the Knobloch and Sawyer coal beds were prepared and 7½-minute topographic maps were used in the preparation of overburden maps.

PREVIOUS GEOLOGIC WORK

The outcrops of the major coal beds as well as the burned areas within the Ashland area were originally mapped by Bass (1932). Two small strippable coal deposits within the Ashland coal deposit were mapped by Brown and others (1954, p. 196) and described as the Home Creek and Cook Creek deposits. These two strippable areas were also included in a report on the strippable coal resources of Montana by Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

Most of the surface over the Ashland coal deposit is privately owned. The deposit lies within the land grant to Burlington Northern, Inc., and although it has conveyed the surface, the railroad has retained most minerals including coal in the odd-numbered sections outside the Custer National Forest. The State of Montana owns both surface and coal in sec. 16 and 36 of each township. Some coal along the tributaries of Otter Creek, including the East Fork of Otter Creek and Home Creek, is privately owned. The federal land outside the forest is administered by the U.S. Bureau of Land Management and that within the Custer National Forest by the U.S. Forest Service.

SURFACE FEATURES AND LAND USE

The most prominent surface feature in the Ashland area is the great mass of clinker formed by the burning of the Knobloch coal bed. In many places, the clinker is more than 100 feet thick. Along Otter Creek and its tributaries, the clinker forms high steep-sided banks and cliffs of reddish or multicolored altered rock, which supports the growth of ponderosa pine. The multicolored clinker, Table 40.–Proximate analysis, forms of sulfur, and heating value, Ashland coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7061 3S R45E S14 CBAB	72 to 80 ft.	273	Knobloch	A	30.050	28.655	37.237	4.057	.142	.000	.016	.127	8275
				B		40.966	53.234	5.801	.204	.000	.023	.181	11829
				C		43.488	56.512		.216	.000	.024	.192	12558
	111 to 117 ft.	274		A	28.400	28.777	38.631	4.192	.169	.000	.017	.152	8576
				B		40.191	53.954	5.855	.236	.000	.024	.212	11978
				C		42.691	57.309		.251	.000	.025	.226	12723
	117 to 121 ft.	275		A	29.280	26.512	38.336	5.872	.191	.000	.024	.167	8226
				B		37.489	54.208	8.303	.270	.000	.034	.236	11631
				C		40.883	59.117		.294	.000	.037	.258	12685
SH-7062 3S R45E S26 DBAC	60 to 68 ft.	276	Knobloch	A	27.630	30.525	37.150	4.695	.133	.017	.017	.099	8431
				B		42.179	51.333	6.488	.183	.023	.023	.137	11650
				C		45.105	54.895		.196	.024	.024	.147	12458
	68 to 76 ft.	277		A	26.560	31.255	37.957	4.228	.117	.017	.017	.084	8759
				B		42.559	51.685	5.757	.160	.023	.023	.114	11927
				C		45.158	54.842		.170	.024	.024	.121	12655
	76 to 85 ft.	278		A	26.020	29.107	39.376	5.497	.160	.000	.008	.152	8591
				B		39.345	53.226	7.430	.216	.000	.011	.205	11612
				C		42.502	57.498		.234	.000	.012	.221	12544
	85 to 94 ft.	279		A	27.040	29.232	40.055	3.673	.131	.016	.016	.098	8704
				B		40.065	54.900	5.035	.180	.022	.022	.135	11930
				C		42.189	57.811		.189	.024	.024	.142	12562
	94 to 103 ft.	280		A	25.700	30.066	38.376	5.858	.159	.026	.044	.088	8758
				B		40.465	51.650	7.884	.214	.036	.059	.119	11787
				C		43.929	56.071		.232	.039	.064	.129	12796
	103 to 112 ft.	281		A	27.250	30.513	38.154	4.083	.115	.016	.016	.082	8642
				B		41.942	52.445	5.613	.158	.023	.023	.113	11879
				C		44.436	55.564		.168	.024	.024	.120	12586
	112 to 116 ft.	282		A	28.220	29.488	38.073	4.220	.239	.017	.017	.205	8643
				B		41.081	53.041	5.879	.333	.024	.024	.286	12041
				C		43.646	56.354		.354	.025	.025	.303	12793
SH-7067 3S R45E S12 AABD	101 to 111 ft.	287	Knobloch	A	29.470	28.253	38.208	4.069	.119	.008	.016	.095	8395
				B		40.058	54.173	5.769	.168	.011	.022	.134	11903
				C		42.511	57.489		.178	.012	.024	.143	12632
	111 to 119 ft.	288		A	28.200	29.082	38.211	4.507	.106	.016	.016	.074	8536
				B		40.504	53.219	6.278	.148	.023	.023	.103	11888
				C		43.217	56.783		.158	.024	.024	.109	12684
	119 to 127 ft.	289		A	28.120	29.660	37.624	4.596	.119	.016	.016	.087	8495
				B		41.263	52.343	6.394	.165	.022	.022	.121	11818
				C		44.082	55.918		.177	.024	.024	.130	12625
	127 to 136 ft.	290		A	28.860	27.862	36.471	6.807	.132	.008	.025	.099	8242
				B		39.165	51.267	9.568	.185	.012	.035	.139	11586
				C		43.309	56.691		.205	.013	.038	.154	12812
	136 to 144 ft.	291		A	28.620	27.997	37.616	5.767	.109	.016	.016	.078	8337
				B		39.223	52.698	8.079	.153	.022	.022	.109	11680
				C		42.670	57.330		.167	.024	.024	.119	12707
	144 to 153 ft.	292		A	28.520	28.362	38.565	4.553	.163	.009	.017	.137	9070
				B		39.679	53.952	6.369	.228	.012	.024	.192	12689
				C		42.378	57.622		.243	.013	.026	.205	13552
	153 to 154 ft.	293		A	29.440	26.880	37.404	6.275	.450	.008	.070	.373	8216
				B		38.096	53.010	8.894	.638	.011	.099	.528	11643
				C		41.815	58.185		.701	.012	.109	.580	12780

SH-7068 3S R45E S10 BDDC	115 to 125 ft.	295	Knobloch	A	30.180	28.698	36.762	4.360	.130	.000	.024	.105	8196
				B		41.103	52.652	6.245	.186	.000	.035	.151	11739
				C		43.841	56.159		.198	.000	.037	.161	12521
	125 to 134 ft.	296		A	31.070	27.610	36.813	4.507	.114	.015	.015	.083	8047
				B		40.055	53.407	6.538	.165	.022	.022	.121	11674
				C		42.857	57.143		.176	.024	.024	.129	12490
	134 to 142 ft.	297		A	32.350	27.269	36.028	4.353	.136	.023	.060	.053	7981
				B		40.308	53.257	6.435	.201	.034	.089	.078	11798
				C		43.081	56.919		.215	.036	.096	.084	12609
	142 to 152 ft.	298		A	30.980	27.152	36.419	5.449	.143	.008	.040	.095	8004
				B		39.339	52.766	7.895	.207	.011	.057	.138	11596
				C		42.711	57.289		.224	.012	.062	.150	12590
	152 to 160 ft.	299		A	32.070	26.572	36.445	4.913	.158	.008	.024	.127	7671
				B		39.117	53.651	7.232	.233	.012	.035	.186	11293
				C		42.167	57.833		.251	.013	.038	.201	12173
	160 to 164 ft.	300		A	32.030	27.882	34.970	5.118	.232	.008	.008	.216	7893
				B		41.021	51.449	7.530	.342	.012	.012	.318	11612
				C		44.361	55.639		.370	.013	.013	.344	12558
SH-7071 3S R45E S8 ABBC	139 to 147 ft.	302	Knobloch	A	26.730	30.459	38.559	4.252	.113	.008	.024	.081	8800
				B		41.570	52.626	5.803	.154	.011	.033	.110	12010
				C		44.131	55.869		.164	.012	.035	.117	12750
	147 to 157 ft.	303		A	27.640	29.963	37.604	4.793	.104	.008	.016	.080	8645
				B		41.409	51.968	6.623	.144	.011	.022	.111	11947
				C		44.346	55.654		.154	.012	.024	.118	12795
	157 to 165 ft.	304		A	28.730	29.884	37.128	4.258	.113	.008	.040	.064	8564
				B		41.931	52.095	5.974	.158	.011	.056	.090	12017
				C		44.595	55.405		.168	.012	.060	.096	12780
	165 to 169 ft.	305		A	26.160	30.526	37.911	5.403	.146	.008	.008	.130	8655
				B		41.340	51.342	7.317	.198	.011	.011	.176	11721
				C		44.604	55.396		.214	.012	.012	.190	12646
SH-7064 3S R46E S8 CACC	90 to 97 ft.	283	Sawyer	A	31.490	28.978	35.506	4.026	.352	.015	.015	.321	7965
				B		42.297	51.827	5.876	.514	.022	.022	.469	11627
				C		44.938	55.062		.546	.024	.024	.499	12353
	97 to 100 ft.	284		A	31.540	33.051	29.396	6.013	.916	.017	.221	.678	7740
				B		48.278	42.939	8.783	1.338	.025	.322	.991	11306
				C		52.927	47.073		1.467	.027	.353	1.087	12394
SH-7066 2S R45E S36 CDCD	82 to 92 ft.	286	Sawyer	A	31.610	28.117	35.601	4.672	.297	.015	.008	.274	8015
				B		41.112	52.056	6.832	.435	.022	.011	.401	11720
				C		44.127	55.873		.467	.024	.012	.431	12579
SH-7070 2S R45E S21 CBDA	152 to 162 ft.	301	Sawyer	A	32.910	30.161	32.014	4.914	.400	.008	.086	.306	7814
				B		44.957	47.718	7.325	.597	.012	.129	.456	11646
				C		48.510	51.490		.644	.013	.139	.492	12567

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 41.–Major ash constituents, Ashland coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7061 3S 45E S14 CBAB	72 to 80 ft.	273	Knobloch	21.2	27.1	4.3	.2	3.8	8.4	.6	26.9	6.1	.6	99.2
	111 to 121 ft.	274-275		17.6	21.5	3.8	.2	3.1	6.2	.1	37.9	6.5	.7	97.6
SH-7062 3S 45E S26 DBAC	60 to 116 ft.	276-282	Knobloch	18.1	23.8	3.4	.1	6.1	3.2	.1	34.1	7.9	.7	97.5
SH-7067 3S 45E S12 AABD	101 to 154 ft.	287-293	Knobloch	17.2	20.1	4.1	.4	3.1	7.6	.3	36.4	8.0	.7	97.9
SH-7068 3S 45E S10 BDDC	115 to 164 ft.	295-300	Knobloch	18.7	19.0	4.1	.2	2.8	8.2	.5	33.3	8.0	.7	95.5
SH-7071 3S 45E S8 ABBC	139 to 169 ft.	302-305	Knobloch	20.3	23.8	4.3	.3	3.8	6.3	.3	31.9	5.4	.8	97.2
SH-7064 3S 46E S8 CACC	90 to 100 ft.	283-284	Sawyer	12.4	19.7	7.3	.3	4.2	10.2	2.3	20.5	20.0	.5	97.4
SH-7066 2S 45E S36 CDCD	82 to 92 ft.	286	Sawyer	18.0	18.8	5.5	.6	3.1	11.8	1.4	25.9	11.8	.5	97.4
SH-7070 2S 45E S21 CBDA	152 to 162 ft.	301	Sawyer	16.6	18.5	7.1	.4	3.5	10.5	1.7	22.1	14.9	.5	95.8

the large terrace levels above the river valleys, which support thin stands of ponderosa pine, and the barren buttes in the background present picturesque scenery.

The surface in the Ashland coal field is deeply dissected along the valleys of Otter Creek, the East Fork of Otter Creek, and Home Creek. Beyond and above the clinkered areas, the surface is rolling and supports the growth of native grasses. The divide between Otter Creek and Pumpkin Creek to the east is sharp and is covered with ponderosa pine.

The flood plain of Otter Creek is about ¾ of a mile wide in the Ashland area. Flood plains of Home Creek and East Fork of Otter Creek are about ¼ of a mile wide. In T. 2 S., R. 44 and 45 E., the tributaries of the Tongue River are relatively short and steep and head in the Cook Mountains; these mountains form a high divide, which separates the East Fork of Otter Creek from Beaver Creek to the north.

The principal land use within the Ashland coal field is livestock grazing. Hay is raised as a principal crop in the meadows along the valley bottoms of Otter Creek, its tributaries, and Tongue River. Some grain is cultivated on the rolling terrain above the rugged topography developed on the clinker. Lumbering is limited to the ponderosa pine stands growing on the higher ground surrounding Ashland.

GEOLOGIC STRUCTURE

The strata in the Ashland coal field are nearly flat. Along the East Fork of Otter Creek, the dip is about 20 feet per mile to the southwest. In T. 2 S., R. 44 and 45 E., the dip is about 40 feet per mile to the south as shown by drill hole data of the Sawyer coal bed. Some reversals do occur, and one of these, near the center of T. 2 S., R. 45 E., coincides with the topographic high of the Cook Mountains.

COAL BEDS

The Knobloch and Sawyer coal beds both contain strippable reserves in the Ashland coal deposit. The Knobloch, ranging in thickness from 40 to 58 feet, is the more important. To the north, in T. 2 S., R. 44 and 45 E., it is 40 to 50 feet thick, but farther south, in T. 3 S., R. 45 and 46 E., it is 50 to 58 feet thick.

The Sawyer coal bed, about 165 feet above the Knobloch bed, is about 10 feet thick as measured in drill holes SH-7064, sec. 8, T. 3 S., R. 46 E., and SH-7070, sec. 21, T. 2 S., R. 45 E. In this latter drill hole, an upper bench 6 feet thick may be the C or D bed described by Bass (1932, p. 55). A surface mine in sec. 3, T. 3 S., R. 45 E., is producing from the Sawyer coal bed. Near the mine, in drill hole SH-7066, sec. 36, T. 2 S., R. 45 E., the Sawyer coal bed has a measured thickness of 14 feet.

Other beds that are minable in the northeastern part of the area (Pl. 13B) are the C and D coal beds, which have a combined thickness as great as 11 feet, and the A bed, which has a thickness of 9 feet. Sections of the Sawyer bed, the A bed about 80 feet below it, and the D bed about 220 feet above it, were measured by Bass (1932).

Two other beds in the area may correlate with the Flowers-Goodale and Terret beds described by Bass (1932, p. 53). Both are below the Knobloch bed; the upper bed has a thickness of 8 feet in drill hole SH-7067 in sec. 12, T. 3 S., R. 45 E. The gamma log of an oil well in the NE¼ sec. 28, T. 3 S., R. 45 E., shows a coal bed at an altitude of 2,973 feet, which is very near the same as the bed below the Knobloch in drill hole SH-7067. The gamma log shows a 3-foot bench separated by an 8-foot parting from a 6-foot bench. A lower bed, at an altitude of 2,844 feet, has a thickness of 6 feet.

COAL QUALITY

Only one earlier report of analysis of coal from this area is available; that sample was obtained from the Coal Creek mine in sec. 3, T. 3 S., R. 45 E. In this analysis, the moisture content is 30%, volatile matter is 29.3%, fixed carbon is 35.8%, ash content is 4.9%, sulfur content is 0.5%, hydrogen content is 6.5%, carbon content is 48.6%, nitrogen content is 0.7%, oxygen content is 38.8%, and the heating value is 8,160 Btu.

Thirty-one core samples obtained from the Ashland coal field on this project were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value are shown in Table 40, and major ash constituents are shown in Table 41.

COAL RESERVES

The Knobloch coal bed contains large strippable reserves. The areas of greatest potential are along the East Fork of Otter Creek and along Home Creek, where the Knobloch bed is thickest and the terrain is most favorable to strip mining.

Strippable reserves in the Knobloch coal bed total 2,696,200,000 tons and in the A, C, and Sawyer coal beds 357,490,000 tons (Table 39).

Table 42.—Reserves, overburden, overburden ratio, acres, and tons/acre, Colstrip coal deposit.

ROSEBUD BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	523.86	646.4	1.23	12,143.7	43,137.4
50 to 100	457.43	1,281.06	2.8	10,589.3	43,198.5
100 to 150	457.97	2,146.19	4.69	10,646.1	43,017.8
	Total 1,439.26	Total 4,073.65	Average 2.83	Total 33,379.1	Average 43,118.6

COLSTRIP COAL DEPOSIT

LOCATION

The Colstrip coal deposit (Pl. 14) is in T. 1 and 2 N., R. 38, 39, 40, 41, and 42 E., and T. 1 S., R. 40 and 41 E., Rosebud and Treasure Counties. The community of Colstrip, in sec. 34, T. 2 N., R. 41 E., had a population of 304 in 1960. As a result of expanded mining operations and construction of two new 350-megawatt power plants just east of Colstrip, the population has increased dramatically. The Montana Power Company purchased the community of Colstrip, along with mining leases and mining equipment, from Burlington Northern, Inc., in 1959. Western Energy Company, a subsidiary of The Montana Power Company, operates the Rosebud mine near Colstrip and ships the coal by unit train to The Montana Power Company 180-megawatt steam generation plant at Billings and to markets in the upper Midwest.

Another strip mine a few miles south of Colstrip is the Big Sky mine, opened in 1969 and operated by Peabody Coal Company. Coal from this mine is being shipped by unit train to northern Minnesota for use in power generation.

Surface mining in the Colstrip area began in 1924, when the Northwestern Improvement Company opened the pit in the Rosebud coal bed near Colstrip to supply coal for locomotives of the parent Northern Pacific (now Burlington Northern, Inc.). The mine operated until the mid 50's but closed when coal was no longer needed for steam locomotives. Western Energy Company reopened the Colstrip mine in 1968.

FIELD WORK AND MAP PREPARATION

The field work in the Colstrip area was conducted entirely by the staff of Burlington Northern, Inc., under the supervision of Virgil W. Carmichael in 1964, using the method developed by Burlington Northern (Carmichael, 1967). The field method involved establishing temporary benchmarks throughout the area and obtaining vertical control through the use of closely controlled altimeter surveys. Holes were drilled and cores were taken to obtain quantitative and qualitative information on the coal and to obtain structural information for preparation of overburden maps. A few of the 69 drill holes penetrated the underlying McKay coal bed.

The overburden map for the Colstrip area was completed during the winter of 1964-65 by Burlington Northern personnel.

PREVIOUS GEOLOGIC WORK

Geology in the Colstrip area was mapped and described by Dobbin (1929) and by Kepferle (1954). Ayler, Smith, and Deutman (1969) included the area in their report on the strippable coal resources in Montana.

LAND OWNERSHIP

The coal field lies within the land grant of odd-numbered sections to Burlington Northern, Inc., who obtained possession of additional land in T. 1 and 2 N., R. 39, 41, and 42 E. Burlington Northern has sold some of its surface and minerals to The Montana Power Company but has retained title to much of the surface in the Colstrip area. The Federal Government owns the coal in the even-numbered sections in the Colstrip area except for sec. 16 and 36 in each township, which are owned by the State of Montana.

SURFACE FEATURES AND LAND USE

The Colstrip coal deposit is on the divide between Rosebud Creek to the east and Armells Creek. Most of the divide is gently rolling, but near the northern and eastern edges of the mapped area, it is relatively steep and deeply dissected where the clinker forms a resistant multicolored zone. Farther west, buttes and ridges are capped by clinker from the burning of higher coal beds. Armells Creek is an intermittent stream of gentle gradient, and flows only during periods of heavy precipitation and spring runoff. In the southern part of the mapped area, the valleys are steep sided where the Sawyer coal bed, which lies above the Rosebud bed, has burned and the clinker caps the ridges between the valleys of Coal Bank Creek, Miller Creek, and Cooley Creek. To the west, the Little Wolf Mountains form a high divide between Armells Creek and Sarpy Creek.

Ponderosa pine trees grow along the valley sides throughout the area. Part of the valley of Armells Creek is utilized for dry-land farming. Hay is raised in meadows along the valley bottoms.

GEOLOGIC STRUCTURE

The strata in the coal field are almost horizontal, except where disturbed by a few faults, which have only small displacement. Generally the top of the Rosebud coal bed is highest in T. 2 N., R. 39 E., and lowest in T. 1 N., R. 41 E.

COAL BEDS

The principal coal beds in the Colstrip area are the Rosebud and the McKay beds. Thickness of the Rosebud bed is a maximum of 29 feet in drill hole RB-43, sec. 27, T. 1 N., R. 41 E., and averages about 25 feet throughout the area. In certain parts of the coal field, the Rosebud contains a parting in the center or upper quarter of the coal bed, and in some areas, this parting attains a thickness of as much as 2 feet.

The McKay coal bed is 18 feet below the Rosebud in drill hole RB-48, sec. 13, T. 1 N., R. 41 E., and 61 feet in drill hole RB-58, sec. 5, T. 1 N., R. 41 E. Thickness of the McKay bed averages about 8 feet. Three thinner coal beds in the Tongue River Member below the Rosebud and McKay coal beds have been mapped in the area (Dobbin, 1929). The Stocker Creek coal bed (0 to 12 feet thick) is about 40 feet below the top of the McKay, the Robinson coal bed (0 to 8 feet thick) is about 140 feet below the top of the Stocker Creek bed, and the Burley coal bed (0 to 5 feet thick) is about 60 feet below the Robinson coal bed. A still lower coal bed, the Big Dirty, is about 250 feet below the Burley bed, but it is in the Lebo Shale Member of the Fort Union Formation. It crops out next to the road about 10 miles north of the community of Colstrip. Several coal beds above the Rosebud bed crop out in the Little Wolf Mountains; these include the Lee, Popham, Sawyer, Proctor, and Richard coal beds. The clinker formed as a result of the burning of the Sawyer bed, which is about 300 feet above the Rosebud, caps buttes and ridgetops throughout the area.

COAL QUALITY

Nineteen coal cores obtained on the Colstrip drilling project were analyzed by U.S. Bureau of Mines Grand Forks Coal Research Laboratory. Proximate analysis, ultimate analysis, and heating value are shown in Table 43, and forms of sulfur and ash fusibility are shown in Table 44.

All core samples are of the Rosebud coal except three samples of the McKay.

COAL RESERVES

Reserves in the Colstrip deposit total 1,439,260,000 tons (Table 42).

Table 43.–Proximate analysis, ultimate analysis, and heating value, Colstrip coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Ultimate, %					Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	S	H	C	N	O	
RB-46 1N 41E S15 CDDD	54 to 87 ft.	H-97821	Rosebud	A	21.51	29.71	40.11	8.67	0.77	5.97	53.12	0.79	30.68	9090
				B		37.86	51.09	11.05	0.99	4.55	67.67	1.01	14.73	11580
				C		42.56	57.44		1.11	5.12	76.08	1.13	16.56	13010
	100 to 108 ft.	H-97822	McKay	A	21.76	27.88	42.61	7.75	1.87	5.76	53.07	0.79	30.76	9060
				B		35.63	54.47	9.90	2.39	4.27	67.83	1.01	14.60	11580
				C		39.55	60.45		2.65	4.74	75.29	1.12	16.20	12850
RB-54 1N 40E S27 AABA	145 to 170 ft.	H-97823	Rosebud	A	23.40	28.63	40.11	7.86	0.68	6.11	52.62	0.80	31.93	9050
				B		37.38	52.36	10.26	0.89	4.58	68.69	1.04	14.54	11810
				C		41.65	58.35		0.99	5.11	76.55	1.16	16.19	13160
RB-55 1N 40E S23 BDDB	77 to 101 ft.	H-97824	Rosebud	A	21.48	29.46	36.48	12.58	0.75	5.66	49.42	.72	30.87	8400
				B		37.53	46.44	16.03	0.95	4.17	62.95	.92	14.98	10700
				C		44.69	55.31		1.13	4.96	74.96	1.09	17.86	12740
RB-56 1N 41E S30 BDAD	27½ to 53 ft.	H-97825	Rosebud	A	22.58	28.80	39.92	8.70	0.97	6.04	52.45	.81	31.03	9060
				B		37.20	51.57	11.23	1.26	4.56	67.75	1.04	14.16	11710
				C		41.91	58.09		1.42	5.13	76.32	1.17	15.96	13190
RB-57 1N 40E S11 BABB	80 to 107½ ft.	H-97826	Rosebud	A	23.14	29.58	38.77	8.51	.68	6.08	51.85	.82	32.06	8950
				B		38.48	50.45	11.07	.89	4.57	67.46	1.06	14.95	11650
				C		43.27	56.73		1.00	5.14	75.86	1.19	16.81	13100
RB-58 1N 41E S5 CAAB	56½ to 77½ ft.	H-97827	Rosebud	A	23.07	28.43	40.11	8.39	0.99	6.02	52.36	0.80	31.44	8920
				B		36.96	52.13	10.91	1.28	4.49	68.06	1.04	14.22	11590
				C		41.49	58.51		1.44	5.04	76.40	1.17	15.95	13010
	138 to 146½ ft.	H-97828	McKay	A	24.45	27.89	41.16	6.50	1.41	6.10	52.50	0.81	32.68	8930
				B		36.91	54.49	8.60	1.86	4.48	69.48	1.08	14.50	11820
				C		40.39	59.61		2.04	4.90	76.03	1.18	15.85	12930
RB-59 2N 41E S31 ADAD	71 to 81 ft.	H-97829	McKay	A	22.23	28.78	41.20	7.79	1.23	5.88	52.83	.92	31.35	8980
				B		37.00	52.98	10.02	1.58	4.39	67.93	1.19	14.89	11550
				C		41.12	58.88		1.75	4.88	75.49	1.32	16.56	12830

RB-60 2N 41E S31 BCDC	73 to 99½ ft.	H-97830	Rosebud	A	22.20	29.99	38.92	8.89	1.00	6.01	52.25	0.81	31.04	8990
				B		38.55	50.02	11.43	1.29	4.56	67.15	1.04	14.53	11550
				C		43.52	56.48		1.45	5.15	75.82	1.18	16.40	13050
RB-61 1N 40E S3 BCCC	72 to 97½ ft.	H-97831	Rosebud	A	21.98	29.68	39.53	8.81	1.07	5.93	52.48	0.78	30.93	9020
				B		38.04	50.67	11.29	1.37	4.48	67.26	1.00	14.60	11560
				C		42.87	57.13		1.54	5.05	75.82	1.13	16.46	13030
RB-63 2N 40E S32 ABCD	80 to 100½ ft.	H-97832	Rosebud	A	23.76	28.16	39.03	9.05	0.53	6.03	50.82	0.79	32.78	8680
				B		36.94	51.20	11.86	0.70	4.45	66.65	1.03	15.31	11380
				C		41.91	58.09		0.79	5.05	75.62	1.17	17.37	12920
	100½ to 108 ft.	H-97833		A	21.31	27.53	34.74	16.42	7.20	5.41	43.63	0.71	26.63	7810
				B		34.99	44.15	20.86	9.15	3.87	55.45	0.91	9.76	9930
				C		44.21	55.79		11.56	4.89	70.06	1.15	12.34	12550
RB-64 2N 39E S34 ABCD	35½ to 60 ft.	H-97834	Rosebud	A	22.59	29.38	39.56	8.47	0.82	6.04	52.70	0.79	31.18	8990
				B		37.96	51.10	10.94	1.06	4.56	68.08	1.03	14.33	11610
				C		42.62	57.38		1.19	5.12	76.45	1.15	16.09	13030
RB-65 2N 39E S29 CCCC	115 to 142½ ft.	H-97835	Rosebud	A	22.96	29.68	39.06	8.30	0.81	6.11	52.47	0.78	31.53	9010
				B		38.52	50.70	10.78	1.05	4.62	68.11	1.02	14.42	11700
				C		43.18	56.82		1.18	5.18	76.34	1.14	16.16	13110
RB-66 2N 38E S13 CAAB	52 to 78 ft.	H-97836	Rosebud	A	20.24	30.21	38.38	11.17	0.68	5.76	51.81	0.79	29.79	8820
				B		37.87	48.12	14.01	0.85	4.40	64.95	0.99	14.80	11050
				C		44.04	55.96		0.99	5.11	75.53	1.15	17.22	12850
RB-67 1N 40E S9 CCBC	86 to 112½ ft.	H-97837	Rosebud	A	22.67	28.71	39.24	9.38	0.91	5.97	51.10	0.82	31.82	8840
				B		37.12	50.76	12.12	1.18	4.48	66.09	1.06	15.07	11430
				C		42.25	57.75		1.34	5.10	75.20	1.21	17.15	13000
RB-68 1N 40E S4 DADA	89 to 115 ft.	H-97838	Rosebud	A	23.88	28.99	39.01	8.12	0.74	6.17	51.75	0.79	32.43	8940
				B		38.09	51.25	10.66	0.97	4.63	67.99	1.04	14.71	11740
				C		42.63	57.37		1.09	5.18	76.10	1.16	16.47	13140
RB-69 1N 40E S5 CBBC	73 to 100 ft.	H-97839	Rosebud	A	23.23	28.77	38.66	9.34	0.95	6.04	51.54	0.77	31.36	8800
				B		37.48	50.35	12.17	1.24	4.50	67.13	1.00	13.96	11470
				C		42.67	57.33		1.41	5.13	76.43	1.14	15.89	13060

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 44.–Forms of sulfur and fusibility of ash, Colstrip coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Sulfur	Form of sulfur, %			Fusibility of ash, °F			Real specific gravity
						Sulfate	Pyritic	Organic	Initial deformation temp.	Softening temp.	Fluid temp.	
RB-46			Rosebud	A	0.77	0.03	0.35	0.40	2340	2380	2420	1.50
1N 41E S15	54 to			B	0.99	0.03	0.45	0.51				
CDDD	87 ft.	H-97821		C	1.11	0.04	0.50	0.57				
			McKay	A	1.87	0.05	1.54	0.27	2080	2120	2150	1.53
	100 to			B	2.39	0.07	1.97	0.35				
	108 ft.	H-97822		C	2.65	0.07	2.19	0.39				
RB-54			Rosebud	A	0.68				2160	2200	2240	
1N 40E S27	145 to			B	0.89							
AABA	170 ft.	H-97823		C	0.99							
RB-55			Rosebud	A	0.75				2160	2200	2230	
1N 40E S23	77 to			B	0.95							
BDDB	101 ft.	H-97824		C	1.13							
RB-56			Rosebud	A	0.97							
1N 41E S30	27½ to			B	1.23							
BDAD	53 ft.	H-97825		C	1.42							
RB-57			Rosebud	A	.68				2370	2420	2470	
1N 40E S11	80 to			B	.89							
BABB	107½ ft.	H-97826		C	1.00							
RB-58			Rosebud	A	0.99	0.02	0.58	0.39	2100	2150	2210	1.51
1N 41E S5	56½ to			B	1.28	0.02	0.75	0.50				
CAAB	77½ ft.	H-97827		C	1.44	0.03	0.84	0.56				
			McKay	A	1.41	0.04	1.09	0.27				1.51
	138 to			B	1.86	0.05	1.45	0.36				
	146½ ft.	H-97828		C	2.04	0.06	1.58	0.40				
RB-59			McKay	A	1.23				2100	2150	2200	
2N 41E S31	71 to			B	1.58							
ADAD	81 ft.	H-97829		C	1.75							

RB-60			Rosebud	A	1.00				2100	2150	2200	
2N 41E S31	73 to			B	1.29							
BCDC	99½ ft.	H-97830		C	1.45							
RB-61			Rosebud	A	1.07				2050	2110	2160	
1N 40E S3	72 to			B	1.37							
BCCC	97½ ft.	H-97831		C	1.54							
RB-63			Rosebud	A	0.53	0.03	0.13	0.37	2240	2280	2320	1.51
2N 40E S32	80 to			B	0.70	0.04	0.17	0.49				
ABCD	100½ ft.	H-97832		C	0.79	0.04	0.20	0.56				
				A	7.20	0.29	5.86	1.04	2020	2060	2100	1.70
	100½ ft.			B	9.15	0.37	7.45	1.33				
	108 ft.	H-97833		C	11.56	0.47	9.42	1.68				
RB-64			Rosebud	A	0.82				2140	2180	2220	
2N 39E S34	35½ to			B	1.06							
ABCD	60 ft.	H-97834		C	1.19							
RB-65			Rosebud	A	0.81				2150	2200	2300	
2N 39E S29	115 to			B	1.05							
CCCC	142½ ft.	H-97835		C	1.18							
RB-66			Rosebud	A	0.68				2420	2470	2520	
2N 38E S13	52 to			B	0.85							
CAAB	78 ft.	H-97836		C	0.99							
RB-67			Rosebud	A	0.91				2240	2280	2320	
1N 40E S9	86 to			B	1.18							
CCBC	112½ ft.	H-97837		C	1.34							
RB-68			Rosebud	A	0.74				2180	2230	2300	
1N 40E S4	89 to			B	0.97							
DADA	115 ft.	H-97838		C	1.09							
RB-69			Rosebud	A	0.95				2130	2170	2210	
1N 40E S5	73 to			B	1.24							
CBBC	100 ft.	H-97839		C	1.41							

[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 45.—Reserves, overburden, overburden ratio, acres, and tons/acre, Pumpkin Creek coal deposit.

SAWYER BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	560.0	781.6	1.39	10,726.4	52,209.6
50 to 100	760.8	1,820.2	2.39	14,323.2	53,117.4
100 to 150	647.2	2,580.2	3.98	11,685.4	55,387.2
150 to 200	428.8	2,514.8	5.86	8,416.0	50,950.6
200 to 250	29.7	191.9	6.46	544.0	54,595.6
	Total 2,426.5	Total 7,888.7	Average 3.25	Total 45,695.0	Average 53,102.1

PUMPKIN CREEK COAL DEPOSIT

LOCATION

The Pumpkin Creek coal deposit (Pl. 15) is in T. 2, 3, and 4 S., R. 48 and 49 E., Powder River County. U.S. Highway 212 traverses the northern part of T. 4 S., R. 49 E., and the southern part of T. 3 S., R. 48 E. The Pumpkin Creek coal deposit adjoins the Sonnette coal deposit (Pl. 25) to the south, the Broadus coal deposit (Pl. 18) to the east, the Little Pumpkin Creek coal deposit (Pl. 27) to the northwest, the Threemile Buttes coal deposit (Pl. 24) to the southwest, and the Foster Creek coal deposit (Pl. 16) to the north.

FIELD WORK AND MAP PREPARATION

All of the field work resulting in the present map of Pumpkin Creek coal deposit was done by the Mineral Development Division of Burlington Northern, Inc., during the summer of 1965. Evaluation of the data was completed late in 1966. The field method utilized was developed by Burlington Northern, Inc. (Carmichael, 1967) for areas where adequate topographic maps were not available. Temporary benchmarks for topographic control were established by leveling and then served as base stations for altimeter surveys. Altimeter elevations along with coal outcrops, clinker, and contacts between burned areas and unburned areas were plotted on aerial photos, as were the holes that were drilled to measure coal thickness and depth. Cores were taken for analyses of coal quality.

PREVIOUS GEOLOGIC WORK

The western part of T. 2 and 3 S., R. 48 E., of the Pumpkin Creek coal deposit was mapped by Bass (1932). The eastern part, T. 2 and 3 S., R. 49 and 50 E., was mapped by Bryson (1952). The southern part, in T. 4 S., R. 48 and 49 E., was mapped by Warren (1959). A report titled "Pumpkin Creek Lignite Deposit, Powder River County, Montana", was presented to the University of Idaho as a thesis (Carmichael, 1967). The Pumpkin Creek deposit was also included in reports on strippable coal (Brown and others, 1954, p. 186-190; Ayler, Smith, and Deutman, 1969).

LAND OWNERSHIP

The Pumpkin Creek coal deposit lies within the limits of the land grant of odd-numbered sections to Burlington Northern, Inc. The railroad has conveyed much of the surface but still owns the coal. The State of Montana owns both the surface and the coal in sec. 16 and 36 of each township. The surface of a few scattered tracts is still owned by the Federal Government as is most of the coal, but a small amount of coal along the Pumpkin Creek valley is privately owned. The western edge of the Pumpkin Creek coal deposit is bordered by the Custer National Forest and is under the administrative supervision of the U.S. Forest Service.

SURFACE FEATURES AND LAND USE

The most prominent surface feature is the Pumpkin Creek valley, which trends slightly east of north from the center of T. 3 S., R. 48 E., through T. 2 S., R. 48 E. In the center of T. 3 S., R. 48 E., the valley is divided into a southwest and a southeast branch. The southeast branch is short and heads about 3 miles from the main valley. The numerous tributaries on the east side of Pumpkin Creek trend northwest and those on the west side trend southeast. These relatively short and steep tributaries are bordered by steep-sided ridges supported by the clinker produced by burning of the Sawyer coal bed.

Pumpkin Creek and its tributaries are intermittent streams and flow only during periods of heavy precipitation and spring runoff.

Table 46.—Proximate analysis, ultimate analysis, heating value, and fusibility of ash, Pumpkin Creek coal deposit.

Drill hole and location	Depth sampled	Coal bed & lab. number	Form of analysis 1/	Proximate, %				Ultimate, %					Heating value (Btu)	Fusibility of ash, °F			Real specific gravity
				Moisture	Volatile matter	Fixed carbon	Ash	H	C	N	O	S		Initial deformation temp.	Softening temp.	Fluid temp.	
PC-3 2S 49E S28 BCDD	68 to 73 ft.	Mackin-Walker	A	28.84	28.88	31.15	11.13	6.26	43.33	.76	37.34	1.18	7310	1990	2040	2080	1.59
			B		40.59	43.77	15.64	4.29	60.90	1.07	16.44	1.66	10270				
		I-21802	C		48.11	51.89		5.08	72.18	1.27	19.50	1.97	12180				
	123 to 155½ ft.	Sawyer	A	31.13	28.48	33.58	6.81	6.51	44.78	.74	40.86	.30	7490	2250	2300	2350	1.54
			B		41.36	48.75	9.89	4.44	65.02	1.07	19.15	.43	10880				
		I-21803	C		45.90	54.10		4.93	72.16	1.19	21.24	.48	12080				
PC-9 3S 49E S15 BDBA	19 to 22 ft.	Mackin-Walker	A	30.52	29.81	33.46	6.21	6.55	45.73	.85	39.76	.90	7720	2410	2460	2520	1.53
			B		42.91	48.16	8.93	4.55	65.81	1.23	18.18	1.30	11110				
		I-21804	C		47.12	52.88		5.00	72.27	1.35	19.96	1.42	12200				
	104½ to 130½ ft.	Sawyer	A	32.21	28.01	32.64	7.14	6.58	44.14	.74	40.98	.42	7370	2190	2240	2320	1.55
			B		41.33	48.14	10.53	4.41	65.11	1.10	18.23	.62	10870				
		I-21805	C		46.19	53.81		4.93	72.78	1.23	20.37	.69	12150				
PC-15 3S 49E S32 DCCC	52 to 64 ft.	Sawyer (U)	A	30.88	28.69	33.89	6.54	6.43	45.27	.82	40.63	.31	7510	2210	2260	2310	1.56
			B		41.51	49.03	9.46	4.34	65.49	1.18	19.08	.45	10870				
		I-21806	C		45.85	54.15		4.79	72.34	1.31	21.07	.49	12000				
	112 to 124 ft.	Sawyer (L)	A	30.97	27.44	31.60	9.99	6.39	42.71	.76	39.80	.35	7140	2080	2140	2190	1.60
			B		39.75	45.78	14.47	4.28	61.87	1.11	17.76	.51	10340				
		I-21807	C		46.47	53.53		5.00	72.34	1.29	20.77	.60	12090				
PC-23 3S 48E S21 CDCC	105 to 142 ft.	Sawyer	A	30.15	28.29	33.11	8.45	6.37	45.18	.77	38.78	.45	7550	2080	2120	2160	1.55
			B		40.50	47.40	12.10	4.32	64.68	1.10	17.15	.65	10810				
		I-21808	C		46.07	53.93		4.92	73.59	1.26	19.49	.74	12300				
PC-29 3S 48E S3 BCCC	89 to 121½ ft.	Sawyer	A	30.99	28.40	33.97	6.64	6.49	45.51	.74	40.38	.24	7570	2140	2190	2270	1.55
			B		41.16	49.22	9.62	4.41	65.95	1.07	18.61	.34	10970				
		I-21809	C		45.54	54.46		4.88	72.97	1.19	20.58	.38	12140				

U = Upper bench of Sawyer
L = Lower bench of Sawyer

[1] /A, as received; B, moisture free; C, moisture and ash free.

The low rolling divide between Pumpkin Creek and Mizpah Creek to the east trends north through the center of T. 2 and 3 S., R. 49 E. Tributaries on the west side of Mizpah Creek trend southeast as do those of Pumpkin Creek.

The principal land use in the area is livestock grazing. Hay is raised along the flood plains of Pumpkin Creek, its tributaries, and Mizpah Creek. Some land is cultivated; winter wheat and other grains are raised by dry-land farming methods.

GEOLOGIC STRUCTURE

The strata in the Pumpkin Creek coal field are almost horizontal, but a slight dip can be detected on the cross sections. The lowest altitude of the top of the Sawyer coal bed is measured as 3,350 feet in drill hole US-L, sec. 32, T. 3 S., R. 48 E. Data obtained from drilling of the Sawyer coal bed show that the strata dip westward 12 to 20 feet per mile, although in places steeper dips are noted. For example, the dip is southwesterly at 65 feet per mile between drill hole PC-1 in sec. 13 and US-C in sec. 22, T. 2 S., R. 49 E. (Carmichael, 1967, p. 41).

Although several faults have been mapped in sec. 3, 4, 17, 18, 32, and 33, T. 3 S., R. 49 E., none have major displacement. A longer fault system, shown in the eastern part of the mapped area, extends more than 20 miles.

COAL BEDS

All strippable reserves that have been mapped in the Pumpkin Creek coal deposit are in the two benches of the Sawyer coal bed (Pl. 15, Section A-A'). The coal bed called the A bed by Bass (1932, p. 54) has not been mapped in the Pumpkin Creek coal deposit. Carmichael (1967) explained that the A bed as defined by Bass is distinct in sec. 32, T. 1 S., R. 48 E., but combines with the Sawyer bed somewhere between that point and drill hole PC-31, sec. 21, T. 2 S., R. 48 E., where the Sawyer bed is 31 feet thick. The Sawyer bed splits in sec. 24, T. 3 S., R. 48 E., where the parting is 1 foot thick in drill hole PC-17. The parting thickens to 15 feet in drill hole PC-22 near the west line of sec. 33, T. 3 S., R. 48 E. The split is greatest in the southeastern part of the coal deposit, where it measured 48 feet in drill hole PC-15, sec. 32, T. 3 S., R. 49 E. There the outcrop of the lower bench is prominent.

Numerous sections of the Mackin-Walker coal bed were measured in the northern part of T. 3 S., R. 49 E., (Bryson, 1952), where the thickness ranges from 2 feet 3 inches to 3 feet 11 inches. Farther southwest, the bed is less than 2 feet thick and too thin to map (Bryson, 1952, p. 85, 96). The Mackin-Walker bed was named for a mine in T. 2 S., R. 49 E., where the bed is 5 feet thick (Bryson, 1952, p. 76).

COAL QUALITY

Eight cores of the Sawyer coal bed were obtained during the field program conducted by the Mineral Development Division of Burlington Northern, Inc., and were analyzed by the U.S. Bureau of Mines, Grand Forks Coal Research Laboratory. Proximate analysis, ultimate analysis, heating value, and fusibility of ash are shown in Table 46.

COAL RESERVES

Coal reserves in the Sawyer bed total 2,426,500,000 tons (Table 45).

FOSTER CREEK COAL DEPOSIT

LOCATION

The Foster Creek coal deposit (Pl. 16A, B, and C) is in T. 1 and 2 N., R. 46, 47, and 48 E., and T. 1 and 2 S., R. 46, 47, and 48 E., Custer and Powder River Counties, about 35 miles south of Miles City and directly west of Volborg. The area borders the Pumpkin Creek (Pl. 15) and Little Pumpkin Creek (Pl. 27) coal deposits to the south.

FIELD METHODS AND MAP PREPARATION

The field work on the Foster Creek area was completed during the summer of 1966 under a cooperative agreement between the Montana Bureau of Mines and Geology and Burlington Northern, Inc. The field work was under the supervision of Virgil W. Carmichael of Burlington Northern, assisted by Loren A. Williams of Burlington Northern, and by Ernest H. Gilmour of the Montana Bureau of Mines and Geology. Field methods were those developed by Burlington Northern, Inc., (Carmichael, 1967).

PREVIOUS GEOLOGIC WORK

Most of the Foster Creek coal deposit was included in the U.S. Geological Survey report on the Ashland coal field (Bass, 1932). Additional information was prepared by Brown and others (1954), Gilmour and Williams (1969), and Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

The Foster Creek coal field lies within the land grant to Burlington Northern, Inc. (then the Northern Pacific

Table 47.—Reserves, overburden, overburden ratio, acres, and tons/acre, Foster Creek coal deposit.

TERRET, FLOWERS–GOODALE, AND KNOBLOCH BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 60	681.82	1,783.40	2.61	33,459.2	20,377.7
60 to 90	379.78	2,274.41	5.98	18,777.6	20,225.1
90 to 120	366.30	3,527.75	9.63	17,472.0	20,964.9
	Total 1,427.90	Total 7,585.56	Average 5.31	Total 69,708.8	Average 20,483.7

TERRET BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 60	214.08	682.15	3.18	12,800.0	16,725.0
60 to 90	129.57	941.67	7.26	7,776.0	16,662.8
90 to 120	117.22	1,389.77	11.85	6,886.4	17,021.9
	Total 460.87	Total 3,013.59	Average 6.53	Total 27,462.4	Average 16,782.1

FLOWERS–GOODALE BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 60	119.54	355.04	2.97	6,662.4	17,942.5
60 to 90	75.88	514.97	6.78	4,249.6	17,855.8
90 to 120	63.48	713.63	11.24	3,532.8	17,968.8
	Total 258.9	Total 1,583.64	Average 6.11	Total 14,444.8	Average 17,924.4

KNOBLOCH BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 60	348.2	746.21	2.14	13,996.8	24,877.1
60 to 90	174.33	817.77	4.69	6,752.0	25,819.0
90 to 120	185.6	1,424.35	7.67	7,052.8	26,315.8
	Total 708.13	Total 2,988.33	Average 4.22	Total 27,801.6	Average 25,470.8

Railway). Under the land grant, the railroad was given available odd-numbered sections in an area 60 miles on each side of the railroad right-of-way. Sec. 16 and 36 of each township were granted to the State of Montana for school land. The other even-numbered sections were retained by the Federal Government until either homesteaded or sold.

Burlington Northern has retained most of the mineral rights although it has conveyed the surface ownership. The State of Montana has retained all surface and mineral rights. The Federal Government, although it has sold or allowed homesteading of the surface, has retained the mineral rights.

SURFACE FEATURES AND LAND USE

Surface features in the Foster Creek coal field range from the broad, nearly level valley of the lower reach of Pumpkin Creek and its west tributaries, to the steep-sided rugged ridges between drainages. The burning of the Knobloch and Flowers-Goodale coal beds has created clinker, which forms precipitous slopes near the ridge lines. Foster Creek, which heads in the southern part of T. 1 N., R. 47 E., and flows northward, is an intermittent stream and carries water only during periods of heavy precipitation and spring runoff. Pumpkin Creek has pools of water all year but has periods of no flow. Except where dammed, the west tributaries of Pumpkin Creek are dry.

Table 48.–Proximate analysis, ultimate analysis, and heating value, Foster Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Ultimate, %					Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	S	H	C	N	O	
FC-6 1S 48E S29 AADD	48 to 59 ft.	I-46486	Knobloch	A	33.14	27.09	33.11	6.66	0.37	6.50	44.29	0.71	41.47	7380
				B		40.52	49.52	9.96	0.56	4.21	66.25	1.07	17.95	11040
				C		45.00	55.00		0.62	4.68	73.59	1.18	19.93	12260
FC-11 1S 47E S3 ACAC	84 to 100 ft.	I-46487	Knobloch	A	30.62	27.96	33.06	8.36	0.32	6.53	45.11	0.71	38.97	7500
				B		40.29	47.66	12.05	0.46	4.50	65.01	1.02	16.96	10810
				C		45.81	54.19		0.52	5.12	73.92	1.16	19.28	12290
	212 to 220 ft.	I-46488	Flowers-Goodale	A	31.29	26.20	35.23	7.28	0.40	6.44	45.49	0.71	39.68	7550
				B		38.13	51.27	10.60	0.59	4.30	66.20	1.04	17.27	10990
				C		42.65	57.35		0.66	4.81	74.05	1.16	19.32	12290
FC-16 1N 48E S17 CABB	53 to 62 ft.	I-46489	Terret	A	30.46	27.37	37.03	5.14	0.21	5.95	47.78	0.75	40.17	7820
				B		39.35	53.25	7.40	0.30	3.69	68.70	1.08	18.83	11240
				C		42.49	57.51		0.32	3.99	74.19	1.16	20.34	12140
FC-28 1N 47E S21 ACBC	37 to 38 ft.	I-46490	Lay Creek	A	28.45	27.86	31.58	12.11	0.39	6.33	43.73	0.70	36.74	7360
				B		38.93	44.14	16.93	0.54	4.43	61.11	0.98	16.01	10280
				C		46.86	53.14		0.65	5.33	73.56	1.18	19.28	12380
	74 to 87 ft.	I-46491	Flowers-Goodale	A	30.25	26.62	34.11	9.02	0.77	6.26	45.07	0.71	38.17	7570
				B		38.16	48.91	12.93	1.11	4.16	64.62	1.02	16.16	10860
				C		43.83	56.17		1.27	4.77	74.22	1.17	18.57	12470
	197 to 208 ft.	I-46492	Terret	A	30.05	26.58	37.12	6.25	0.24	6.11	47.59	0.73	39.08	7860
				B		37.99	53.08	8.93	0.35	3.98	68.04	1.04	17.66	11240
				C		41.72	58.28		0.38	4.37	74.71	1.14	19.40	12350
FC-29 1N 46E S21 BCCB	115 to 117 ft. 118 to 121 ft.	I-46493	Knobloch	A	29.58	28.17	33.60	8.65	1.61	6.35	46.36	0.75	36.28	7840
				B		40.00	47.71	12.29	2.28	4.36	65.84	1.07	14.16	11140
				C		45.60	54.40		2.60	4.97	75.05	1.22	16.16	12700
FC-32 1N 47E S25 CCCC	83 to 95½ ft.	I-46494	Flowers-Goodale	A	31.54	26.98	34.21	7.27	0.36	6.45	44.96	0.70	40.26	7540
				B		39.41	49.96	10.63	0.53	4.30	65.67	1.03	17.84	11010
				C		44.10	55.90		0.60	4.81	73.48	1.15	19.96	12320
	177 to 186½ ft.	I-46495	Terret	A	31.63	26.75	35.38	6.24	0.20	6.25	46.16	0.70	40.45	7630
				B		39.13	51.75	9.12	0.30	4.00	67.52	1.02	18.04	11150
				C		43.06	56.94		0.33	4.40	74.30	1.12	19.85	12270

1/A, as received; B, moisture free; C, moisture and ash free.

Table 49.–Forms of sulfur and fusibility of ash, Foster Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Form of sulfur, %				Fusibility of ash, °F		
					Sulfur	Sulfate	Pyritic	Organic	Initial deformation temp.	Softening temp.	Fluid temp.
FC-6 1S 48E S29 AADD	48 to 59 ft.	I-46486	Knobloch	A	.37	.03	.13	.21	2290	2320	2350
				B	.56	.04	.20	.32			
				C	.62	.04	.22	.35			
FC-11 1S 47E S3 ACAC	84 to 100 ft.	I-46487	Knobloch	A	.32	.01	.07	.24	2230	2260	2290
				B	.46	.02	.10	.34			
				C	.52	.02	.11	.39			
	212 to 220 ft.	I-46488	Flowers-Goodale	A	.40	.03	.07	.30	2190	2240	2290
				B	.59	.05	.11	.43			
				C	.66	.05	.12	.49			
FC-16 1N 48E S17 CABB	53 to 62 ft.	I-46489	Terret	A	.21	.01	.03	.17	2250	2280	2310
				B	.30	.02	.04	.24			
				C	.32	.02	.04	.26			
FC-28 1N 47E S21 ACBC	37 to 38 ft.	I-46490	Lay Creek	A	.39	.02	.03	.34	2440	2470	2500
				B	.54	.03	.04	.47			
				C	.65	.03	.05	.57			
	74 to 87 ft.	I-46491	Flowers-Goodale	A	.77	.02	.55	.20	2050	2100	2190
				B	1.11	.03	.78	.29			
				C	1.27	.04	.90	.34			
	197 to 208 ft.	I-46492	Terret	A	.24	.02	.13	.12	2030	2080	2180
				B	.35	.03	.18	.16			
				C	.38	.04	.20	.18			
FC-29 1N 46E S21 BCCB	115 to 117 ft. 118 to 121 ft.	I-46493	Knobloch	A	1.61	.02	1.21	.37	2000	2050	2140
				B	2.28	.03	1.72	.52			
				C	2.60	.04	1.97	.60			
FC-32 1N 47E S25 CCCC	83 to 95½ ft.	I-46494	Flowers-Goodale	A	.36	.02	.07	.28	2210	2240	2270
				B	.53	.02	.11	.40			
				C	.60	.02	.12	.45			
	177 to 186 ½ ft.	I-46495	Terret	A	.20	.00	.02	.18	2040	2150	2260
				B	.30	.00	.03	.27			
				C	.33	.00	.03	.33			

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 50.–Major ash constituents, Foster Creek coal deposit.

Drill hole and location	Depth sampled	Sample number	Coal bed	Constituent, %											
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	LOI @ 800°C	Total
FC-11 1S 47E S3	84 to 100 ft.	GF-66-1200	Knobloch	14.3	18.3	4.7	.3	5.9	1.0	.7	43.1	8.7	.7	.5	98.2
	212 to 220 ft.	GF-66-1202	Flowers-Goodale	14.3	21.3	6.2	.3	4.7	6.2	.1	29.9	12.7	.5	.5	96.7
FC-28 1N 47E S21	74 to 87 ft.	GF-66-1205	Flowers-Goodale	13.5	18.7	9.5	.4	3.8	5.5	.1	28.0	19.4	.3	.5	99.7
	197 to 208 ft.	GF-66-1208	Terret	12.8	24.8	7.9	.3	5.0	8.8	.6	26.2	11.9	.3	.4	99.0
FC-32 1N 47E S25	83 to 95½ ft.	GF-66-1211	Flowers-Goodale	17.2	22.6	6.1	.4	4.9	4.5	.6	30.3	11.8	.5	.3	99.2
	177 to 186½ ft.	GF-66-1213	Terret	11.9	24.9	7.0	.3	4.7	8.4	1.2	30.3	8.9	.3	.8	98.7

The principal land uses in this area are livestock grazing and dry-land farming. Many areas provide large gently sloping fields for raising winter wheat and other grains. Hay is grown on meadows along the principal valleys throughout the area.

GEOLOGIC STRUCTURE

The regional dip in the Foster Creek area is southwest, as the Terret bed declines from an altitude of 3,150 feet in the northern part to 3,070 feet in the part south of Little Pumpkin Creek. Small anticlinal and synclinal undulations have vertical relief as great as 60 feet (Gilmour and Williams, 1969, p. 3).

COAL BEDS

The three major coal beds in the Foster Creek area are, from lowest to highest, the Terret, Flowers-Goodale, and the Knobloch. The Terret bed is the principal coal bed in the northern part of the area, where the thickness averages about 9 feet over a large area and is a maximum of 11 feet. In the southern half of the mapped area, both the Flowers-Goodale and the Knobloch beds are minable. The Flowers-Goodale is 2 to 14 feet thick, and the Knobloch is 5 to 18 feet thick. In the southern part of the area, the vertical distance between the Flowers-Goodale and the Knobloch, as determined by drilling, is 89 to 119 feet (Gilmour and Williams, 1969, p. 3).

COAL QUALITY

Ten core samples were recovered during the field investigations and were sent to the Grand Forks Coal Research Laboratory, U.S. Bureau of Mines, for analyses. Proximate analysis, ultimate analysis, and heating value are shown in Table 48. Forms of sulfur and fusibility of ash are shown in Table 49, and major ash constituents in Table 50.

COAL RESERVES

The coal reserves in the Foster Creek area total 1,427,900,000 tons. The Knobloch coal bed contains 708,130,000 tons, the Flowers-Goodale bed 258,900,000 tons, and the Terret bed 460,870,000 tons (Table 47).

BROADUS COAL DEPOSIT

LOCATION

The Broadus coal deposit (Pl. 17) is in T. 2, 3, and 4 S., R. 49 and 50 E., Powder River County, about 5 miles northwest of Broadus. The area is bordered on its eastern side by U.S. Highway 312, which connects Broadus with Miles City. U.S. Highway 212 cuts across the southern part of the mapped area. The Broadus coal deposit overlaps the Pumpkin Creek coal deposit (Pl. 15) to the west and borders the Foster Creek coal deposit (Pl. 16). The Sand Creek coal deposit (Pl. 28) is a few miles to the north.

FIELD WORK AND MAP PREPARATION

The field work in the Broadus coal deposit was done in the summer of 1967 as part of a cooperative project between Burlington Northern, Inc., and the Montana Bureau of Mines and Geology to develop information on strippable coal in eastern Montana. Both the railroad and the Bureau supplied a field crew and shared in the drilling expenses. Loren A. Williams of Burlington Northern, Inc., prepared the map from field data during the following winter.

The field method was developed by Burlington Northern, Inc., to evaluate strippable coal in areas where good topographic maps were lacking. This method included establishing a series of temporary bench marks of the area as well as altimeter base stations, and obtaining hundreds of altimeter points for topographic control. Information on the quantity and quality of the coal was obtained by drilling (Carmichael, 1967).

PREVIOUS GEOLOGIC WORK

The northern part of the Broadus coal deposit was mapped by Bryson (1952), and the southern part by Warren (1959). The part that is overlapped by the Pumpkin Creek coal deposit was mapped and described in a thesis by Carmichael (1967). Strippable coal in the Broadus coal bed was included in a report by Ayler, Smith, and Deutman (1969, p. 23), but that report included an area farther south in T. 5 and 6 S., R. 49 and 50 E., which was excluded from the present report because the topography there is rugged and deeply dissected. Some small areas, however, as along Rough Creek and Cache Creek, would provide some strippable coal. The Cache Creek strippable coal deposit in the Broadus coal bed has been described by Matson, Dahl, and Blumer (1968).

LAND OWNERSHIP

As T. 2 and 3 S., R. 49 and 50 E., are within the land grant to Burlington Northern, Inc., the railroad owns the coal in the odd-numbered sections, although it has conveyed most of the surface. In T. 4 S., R. 49 and 50 E., south of the land grant, most of the coal is owned by the

Table 51.—Reserves, overburden, overburden ratio, acres, and tons/acre, Broadus coal deposit.

BROADUS BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	165.92	224.14	1.35	3,737.2	44,396.87
50 to 100	226.83	701.31	3.09	5,796.0	39,135.61
100 to 150	347.07	1,793.59	5.17	8,896.6	39,011.53
	Total 739.82	Total 2,719.04	Average 3.68	Total 18,429.8	Average 40,142.15

Federal Government, although the surface has been conveyed except for a few small tracts. The state owns sec. 16 and 36 in each township in T. 2 and 3 S., but only a fraction of those sections in T. 4 S.

SURFACE FEATURES AND LAND USE

The Broadus coal field on the west side of the broad alluviated Mizpah valley, is drained by Mizpah Creek and its tributaries. The area has moderate to low relief, and the terrain is gently sloping except for a few steep-sided ridges, small mesas, and buttes. The Broadus bed has burned in large areas where it was under a minimal overburden and the burning has formed thick multicolored clinker along the eastern edge of the coal deposit. Locally the clinker is deeply dissected. Mizpah Creek, an intermittent stream flowing most of the year, has periods of no flow in the late summer and autumn. Its tributaries are dry, and water is retained only by earthen dams.

The principal land uses are livestock grazing and dryland farming. The gently sloping terrain above the clinkered areas provides large fields suitable for raising winter wheat and other grains. Hay is raised in sub-irrigated fields along the main valley of Mizpah Creek and its tributaries.

GEOLOGIC STRUCTURE

The strata in the Broadus coal deposit dip generally westward. Minor structural undulations roughly parallel the land surface; the tributaries west of Mizpah Creek are structurally low and the ridges between are structurally high. A fault has been mapped in sec. 10 and 15, T. 4 S., R. 50 E. (Warren, 1959).

COAL BEDS

The Broadus bed is the only bed in the Broadus coal deposit that has strippable reserves. Farther west the Sawyer coal bed, which overlies the Broadus, has been mapped and included in the Pumpkin Creek coal deposit (Pl. 15). In the Broadus coal field the Broadus bed is 100 feet above the base of the Tongue River Member (Warren, 1959; Matson, Dahl, and Blumer, 1968), but farther north, in the Coalwood field, it is 135 feet above the base (Bryson, 1952). The thickness of the Broadus coal bed is 26 feet in drill hole BR-1C, sec. 5, T. 4 S., R. 50 E., and at the abandoned Peerless mine, sec. 23, T. 4 S., R. 50 E. The bed splits and thins northward, as shown in drill hole BR-7C, sec. 16, T. 2 S., R. 50 E., and in drill hole BR-10, sec. 13, T. 2 S., R. 49 E. In drill hole BR-8, sec. 4, T. 2 S., R. 50 E., in the northern end of the deposit, the bed consists of two 5-foot benches. The Broadus coal bed also thins to the south and is 12 feet thick in drill hole SS-2, sec. 36, T. 5 S., R. 49 E. (Matson, Dahl, and Blumer, 1968, p. 41).

A local bed between the Broadus and the Sawyer coal beds is as much as 5 feet thick, as shown in drill hole BR-9 in sec. 36, T. 2 S., R. 49 E.

COAL QUALITY

Small wagon mines, including the Peerless in the south-central part of sec. 23, T. 4 S., R. 50 E., the Victor Stabio in sec. 24, T. 4 S., R. 50 E., the Black Diamond in sec. 11, T. 5 S., R. 50 E., and the Superior in sec. 14, T. 5 S., R. 50 E., were actively supplying the needs of the Broadus community in earlier years. Analytical reports of samples from these mines show a heating value ranging from 6,390 to 7,380 Btu, moisture 29.0 to 33.9%, volatile matter 26.6 to 31.6%, fixed carbon 31.3 to 33.1%, ash 6.0 to 8.1%, and sulfur 0.2 to 0.4% on the "as received" basis (Warren, 1959).

Four core samples were obtained from the Broadus coal bed, and these were analyzed by the U.S. Bureau of Mines, Grand Forks Coal Research Laboratory. Proximate analysis, ultimate analysis, and heating value are shown in Table 52, and major ash constituents and fusibility of ash are shown in Table 53.

COAL RESERVES

Reserves in the Broadus coal deposit total 739,820,000 tons (Table 51).

Table 52.–Proximate analysis, ultimate analysis, and heating value, Broadus coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Ultimate, %					Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	S	H	C	N	O	
BR-1C 4S 50E S5 BCCD	68 to 94 ft.	I-73087	Broadus	A	30.07	28.67	34.89	6.37	.19	6.39	45.69	.67	40.69	7580
				B		41.00	49.89	9.11	.27	4.36	65.34	.96	19.96	10840
				C		45.11	54.89		.30	4.80	71.89	1.05	21.96	11930
BR-6C 3S 50E S7 AAAB	92 to 117 ft.	I-73088	Broadus	A	28.95	28.86	35.29	6.90	.24	6.26	45.82	.67	40.11	7550
				B		40.62	49.67	9.71	.34	4.29	64.50	.94	20.22	10630
				C		44.99	55.01		.37	4.76	71.44	1.04	22.39	11780
BR-7C 2S 50E S16 CCCC	89 to 104 ft.	I-73089	Broadus	A	30.87	27.58	32.48	9.07	.46	6.39	42.79	.70	40.59	7120
				B		39.90	46.98	13.12	.66	4.28	61.89	1.02	19.03	10310
				C		45.92	54.08		.76	4.93	71.24	1.17	21.90	11860
BR-12C 3S 50E S5 AABB	67 to 91½ ft.	I-73090	Broadus	A	29.82	28.81	34.83	6.54	.20	6.38	45.19	.68	41.01	7500
				B		41.05	49.63	9.32	.29	4.38	64.39	.97	20.65	10680
				C		45.27	54.73		.32	4.83	71.00	1.06	22.79	11780

[1]/A, as received; B, moisture free; C, moisture and ash free.

Table 53.–Major ash constituents and fusibility of ash, Broadus coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %											Fusibility of ash, °F		
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total	Initial deformation temp.	Softening temp.	Fluid temp.
BR-1C 4S 50E S5 BCCD	68 to 94 ft.	I-73087	Broadus	16.2	29.0	5.8	.20	5.5	3.6	.94	24.2	8.8	.66	94.9	2350	2400	2450
BR-6C 3S 50E S7 AAAB	92 to 117 ft.	I-73088	Broadus	17.3	19.6	5.6	.60	4.7	1.2	.59	34.9	10.0	.62	95.1	2250	2300	2350
BR-7C 2S 50E S16 CCCC	89 to 104 ft.	I-73089	Broadus	17.8	28.2	5.4	.46	6.3	1.9	.86	27.5	8.4	.58	97.4	2060	2100	2140
BR-12C 3S 50E S5 AABB	67 to 91½ ft.	I-73090	Broadus	16.8	31.2	5.4	.28	4.8	3.0	1.03	26.0	6.2	.62	95.3	2310	2350	2390

Table 54.–Reserves, overburden, overburden ratio, acres, and tons/acre, East Moorhead coal deposit.

T BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	116.21	188.13	1.62	3,533.7	32,883.4
50 to 100	176.58	611.63	3.46	5,054.8	34,931.8
100 to 150	232.42	1,215.70	5.23	6,970.9	33,341.0
	Total 525.21	Total 2,015.46	Average 3.84	Total 15,559.4	Average 33,756.0

EAST MOORHEAD COAL DEPOSIT

LOCATION

The East Moorhead coal deposit (Pl. 18) is in T. 7, 8, and 9 S., R. 50 and 51 E., Powder River County. The area is bounded on the east by exposure and by clinker above the T coal bed, on the south by the Wyoming border, and on the west by increasingly thicker overburden.

FIELD WORK AND MAP PREPARATION

The field work in the East Moorhead coal deposit was done during the summer of 1971; numerous exploration holes were drilled and the surface was mapped on 7½-minute topographic quadrangle maps. Mapping was completed the following winter, when the overburden map was prepared.

PREVIOUS GEOLOGIC WORK

The East Moorhead coal deposit was described in a U.S. Geological Survey open-file report on the Moorhead coal field (Bryson and Bass, 1966).

LAND OWNERSHIP

The Federal Government owns most of the coal rights in the deposit, as the area is south of the land grant to Burlington Northern, Inc., but it has conveyed most of the surface to individuals except in T. 8 S. The State of Montana owns the surface and coal in sec. 16 and 36 in each township.

SURFACE FEATURES AND LAND USE

The East Moorhead coal deposit occupies the highest part of the divide between Little Powder River to the east and Powder River to the west. All the tributaries of Powder River and Little Powder River are intermittent streams, which flow only during periods of heavy precipitation and the spring runoff. Because the drainage pattern has a very strong northwest to north orientation on both sides of the divide, it seems to be structurally controlled. The divide area is grass-covered and gently rolling above the clinker areas. The steep valley sides are formed by resistant clinker produced by burning of the T coal bed. The valley bottoms are relatively flat and the main ones are as much as a mile wide. Buttes are numerous in the area and are capped by clinker. Ponderosa pine trees grow on the clinker along the sides of the valleys.

The principal land uses in the area are livestock grazing and dry-land farming. Various grains are grown on summer fallowed fields, and some hay is raised, especially along the valley bottoms.

GEOLOGIC STRUCTURE

Drill hole data from the T coal bed show a dip to the west. Minor undulation of the surface is apparent in the area.

COAL BEDS

The T coal bed, the only one in the East Moorhead coal deposit that contains economically recoverable coal, has been correlated (Bryson and Bass, 1966) with the Cache coal bed. It is named for Cache Creek west of Powder River (Warren, 1959). The T coal bed is 26 feet thick in drill hole SH-713 in sec. 6, T. 8 S., R. 51 E., in the north-central part of the mapped area, but thins southward and is only 10 feet thick in drill hole SH-718 in sec. 24, T. 9 S., R. 50 E.

COAL QUALITY

Thirteen core samples were obtained from the T coal bed for analyses by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value are shown in Table 55, and major ash constituents of composite samples are shown in Table 56.

COAL RESERVES

Reserves in the T coal bed total 525,210,000 tons (Table 54).

Table 55.—Proximate analysis, forms of sulfur, and heating value, East Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-711 8S R51E S4 BADC	90 to 98 ft.	343	T	A	37.870	27.453	29.620	5.057	.675	.028	.071	.575	6994
				B		44.187	47.673	8.140	1.086	.046	.114	.926	11258
				C		48.102	51.898		1.182	.050	.124	1.008	11255
	98 to 104 ft.	344		A	36.820	29.516	28.640	5.024	.367	.022	.007	.337	7059
				B		46.717	45.331	7.952	.581	.036	.012	.533	11172
				C		50.753	49.247		.631	.039	.013	.579	12137
SH-712 8S R51E S9 BCAB	150 to 158 ft.	345	T	A	37.650	27.567	29.478	5.304	.674	.015	.111	.548	7014
				B		44.213	47.279	8.508	1.081	.024	.178	.879	11250
				C		48.325	51.675		1.182	.026	.195	.961	12296
	158 to 161 ft.	346		A	37.070	27.449	30.776	4.705	.434	.015	.107	.312	7112
				B		43.618	48.905	7.477	.690	.024	.169	.496	11301
				C		47.143	52.857		.745	.026	.183	.536	12214
	161 to 168 ft.	347		A	37.270	26.675	31.813	4.242	.314	.015	.061	.237	7134
				B		42.524	50.714	6.762	.500	.024	.098	.378	11373
				C		45.608	54.392		.537	.026	.105	.406	12198
SH-713 8S R51E S6 DDAD	103 to 112 ft.	348	T	A	36.690	27.647	31.063	4.601	.741	.015	.015	.712	7208
				B		43.669	49.064	7.267	1.171	.023	.023	1.125	11386
				C		47.091	52.909		1.263	.025	.025	1.213	12278
	112 to 122 ft.	349		A	36.630	26.937	32.237	4.796	.321	.022	.007	.291	7147
				B		42.507	50.872	6.621	.507	.035	.012	.459	11278
				C		45.521	54.479		.543	.038	.013	.492	12078
SH-714 8S R51E S30 DBBA	21 to 30 ft.	350	T	A	38.360	26.334	30.635	4.671	.476	.021	.199	.256	6943
				B		42.722	49.701	7.577	.772	.035	.322	.415	11264
				C		46.225	53.775		.835	.037	.349	.449	12188
	30 to 36 ft.	351		A	36.310	27.614	29.410	6.666	.762	.030	.536	.196	7051
				B		43.357	46.178	10.466	1.197	.047	.842	.308	11071
				C		48.425	51.575		1.337	.053	.940	.344	12366
SH-716 8S R50E S36 BADC	50 to 60 ft.	352	T	A	33.940	29.111	31.735	5.213	.360	.017	.077	.266	7592
				B		44.068	48.040	7.892	.545	.026	.117	.402	11493
				C		47.844	52.156		.592	.028	.402	.437	12477
SH-718 9S R50E S24 BBCA	90 to 96 ft.	353	T	A	33.730	27.239	27.474	11.557	.580	.017	.134	.428	6867
				B		41.103	41.458	17.[illegible]	.875	.025	.203	.646	10362
				C		49.785	50.215		1.059	.031	.246	.783	12551
SH-719 9S R50E S19 ABAD	160 to 170 ft.	354	T	A	34.640	27.474	32.215	5.671	.546	.017	.162	.367	7494
				B		42.035	49.289	8.676	.835	.026	.248	.561	11465
				C		46.029	53.971		.914	.029	.271	.614	12554
	170 to 175 ft.	355		A	31.840	19.821	35.187	13.151	1.181	.017	.362	.801	6947
				B		29.081	51.625	19.294	1.732	.025	.531	1.176	10192
				C		36.033	63.967		2.146	.031	.658	1.457	12629

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 56.–Major ash constituents of composite samples, East Moorhead coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-711 8S 51E S4 BADC	90 to 104 ft.	343-344	T	9.5	34.3	6.6	.1	6.1	2.3	.7	13.8	21.3	.3	95.0
SH-712 8S 51E S9 BCAB	150 to 168 ft.	345-347	T	12.1	34.1	6.3	.1	6.4	1.6	.1	17.7	16.6	.4	95.4
SH-713 8S 51E S6 DDAD	103 to 122 ft.	348-349	T	12.0	31.9	5.6	.1	6.3	4.5	1.8	12.0	21.0	.3	95.5
SH-714 8S 51E S30 DBBA	21 to 36 ft.	350-351	T	9.4	20.5	10.5	.1	5.0	1.1	1.1	17.7	21.5	.4	87.3
SH-716 8S 50E S36 BADC	50 to 60 ft.	352	T	14.9	33.8	6.8	.1	6.0	1.0	2.0	16.5	14.0	.4	95.5
SH-718 9S 50E S24 BBCA	90 to 96 ft.	353	T	24.4	12.4	5.5	1.0	2.7	1.3	.9	42.8	5.8	1.0	97.8
SH-719 9S 50E S19 ABAD	160 to 175 ft.	354-355	T	17.4	16.5	8.9	.5	3.1	1.6	1.1	32.1	15.8	.6	97.6

Table 57.—Reserves, overburden, overburden ratio, acres, and tons/acre, Diamond Butte, Goodspeed Butte, and Fire Gulch coal deposits.

CANYON BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	139.21	417.74	3.00	7,848.2	17,737.8
50 to 100	178.78	1,116.38	6.24	9,228.2	19,373.2
100 to 150	100.03	864.26	8.64	4,287.2	23,332.2
	Total 418.02	Total 2,398.38	Average 5.74	Total 21,363.6	Average 19,566.6

COOK BED

Thickness of overburden, ft.	Indicated reserves, million tons	Interburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	128.11	288.3	2.25	2,688.0	47,659.9
50 to 100	225.67	848.69	3.76	4,710.4	47,908.9
100 to 150	275.17	1,492.08	5.42	6,047.8	45,499.2
	Total 628.95	Total 2,629.07	Average 4.18	Total 13,446.2	Average 46,775.9

PAWNEE and COOK BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	73.28	200.89	2.74	2,035.2	36,006.3
50 to 100	152.03	529.71	3.48	3,699.2	41,098.1
100 to 150	111.38	749.6	6.73	2,752.0	40,472.4
	Total 336.69	Total 1,480.2	Average 4.39	Total 8,486.4	Average 39,674.1

DIAMOND BUTTE, GOODSPEED BUTTE, AND FIRE GULCH COAL DEPOSIT

LOCATION

The Diamond Butte (Pl. 19), Goodspeed Butte (Pl. 20), and Fire Gulch (Pl. 21) coal deposits are in T. 6 and 7 S., R. 46, 47, and 48 E., Powder River County. These deposits are bordered on the south by the West Moorhead (Pl. 10A, B, and C), on the north by the Threemile Buttes (Pl. 24) and Sonnette (Pl. 25A and B), and on the northwest corner by the Otter Creek (Pl. 12) coal deposits. Parts of the Fire Gulch and Diamond Butte deposits are outside the boundary, but most of the coal in these three deposits is in the Custer National Forest.

FIELD WORK AND MAP PREPARATION

The Diamond Butte, Goodspeed Butte, and Fire Gulch areas were drilled during the 1971 field season. The geology was mapped from colored photos borrowed from the U.S. Forest Service, supplemented by reference to the report by Warren (1959).

PREVIOUS GEOLOGIC WORK

Except for T. 7 S., R. 46 and 47 E., the area included in the Diamond Butte, Goodspeed Butte, and Fire Gulch deposits was mapped by Warren (1959). That part of the area that is in T. 7 S., R. 45 and 46 E., was described by Bryson and Bass (1966), and by Matson (1970), and the

Table 58.–Proximate analysis, forms of sulfur, and heating value, Diamond Butte coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7121 6S R48E S16 BCAA	90 to 96 ft.	376	Canyon	A	37.030	27.510	31.352	4.109	.274	.007	.059	.207	7138
				B		43.687	49.788	6.525	.435	.012	.094	.329	11336
				C		46.736	53.264		.465	.013	.101	.352	12127
SH-7122 6S R47E S34 CCCD	88 to 90 ft.	377	Local	A	36.400	25.542	32.305	5.754	.493	.000	.077	.416	7100
				B		40.160	50.793	9.047	.775	.000	.121	.654	11164
				C		44.154	55.846		.852	.000	.133	.719	12274
	174 to 178 ft.	378		A	34.070	27.603	30.068	8.259	1.017	.015	.528	.475	7240
				B		41.868	45.605	12.527	1.543	.023	.800	.720	10981
				C		47.864	52.136		1.764	.026	.915	.823	12553
SH-7123 6S R47E S29 DACC	192 to 201 ft.	379	Canyon	A	34.430	28.539	33.301	3.730	.264	.008	.023	.234	7455
				B		43.524	50.787	5.689	.402	.011	.034	.356	11369
				C		46.149	53.851		.427	.012	.037	.378	12055
SH-7124 6S R47E S30 BCBB	56 to 63 ft.	380	Canyon	A	32.270	29.335	35.100	3.296	.262	.016	.016	.230	7897
				B		43.311	51.823	4.866	.387	.023	.023	.340	11660
				C		45.526	54.474		.407	.025	.025	.357	12257
SH-7128 6S R47E S36 ACAC	112 to 122 ft.	383	Canyon	A	36.650	26.294	33.757	3.299	.213	.007	.044	.161	7187
				B		41.507	53.286	5.207	.336	.012	.069	.255	11345
				C		43.787	56.213		.354	.012	.073	.269	11968
SH-7134 6S R48E S29 BBAA	54 to 64 ft.	384	Canyon	A	35.260	27.929	31.654	5.157	.523	.014	.122	.387	7296
				B		43.140	48.894	7.966	.808	.022	.188	.597	11269
				C		46.874	53.126		.878	.024	.204	.649	12245

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 59.—Major ash constituents, Diamond Butte coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7121 6S 48E S16 BCAA	90 to 96 ft.	376	Canyon	10.9	31.6	7.4	.4	9.1	.9	.8	21.6	12.6	.7	96.0
SH-7122 6S 47E S34 CCCD	88 to 90 ft.	377	Local	18.9	18.4	4.3	.5	4.7	6.1	1.5	27.2	14.0	2.2	97.8
	174 to 178 ft.	378		12.5	12.2	11.9	.5	3.4	3.4	1.6	34.2	15.9	.9	96.5
SH-7123 6S 47E S29 DACC	192 to 201 ft.	379	Canyon	10.5	31.0	10.0	.2	7.4	9.7	1.1	10.8	14.1	.6	95.4
SH-7124 6S 47E S30 BCBB	56 to 63 ft.	380	Canyon	10.3	36.3	8.8	.2	12.1	1.0	.4	9.9	14.9	.3	94.2
SH-7128 6S 47E S36 ACAC	112 to 122 ft.	383	Canyon	11.1	33.2	7.8	.3	8.8	8.4	1.1	9.4	12.6	.5	93.2
SH-7134 6S 48E S29 BBAA	54 to 64 ft.	384	Canyon	10.1	26.9	8.9	.2	7.1	6.6	.7	19.3	18.7	.6	99.1

Table 60.–Proximate analysis, forms of sulfur, and heating value, Goodspeed Butte coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7126			Cook	A	33.290	25.291	32.550	8.869	2.054	.054	.840	1.159	6861
6S 46E S28	88 to			B		37.913	48.793	13.294	3.079	.082	1.259	1.738	10285
BABA	91 ft.	381		C		43.726	56.274		3.551	.094	1.453	2.004	11861
	94 to			A	33.710	23.071	30.776	12.443	1.220	.045	.475	.700	6682
	97 ft.	382		B		34.803	46.427	18.771	1.841	.068	.716	1.057	10081
				C		42.845	57.155		2.266	.084	.881	1.301	12410

Table 61.–Major ash constituents, Goodspeed Butte coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7126 6S 46E S28 BABA	88 to 91 ft.	381	Cook	14.2	7.7	11.8	1.1	4.9	.4	.1	32.0	18.4	.5	91.1
	94 to 97 ft.	382		18.3	6.8	7.9	1.2	2.8	.4	.6	46.8	9.2	8	94.8

Table 62.—Proximate analysis, forms of sulfur, and heating value, Fire Gulch coal deposit.

Drill hole and location	Depth sampled	Lab number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7135			Cook	A	33.620	27.425	34.217	4.738	.258	.022	.057	.179	7530
6S 48E S29	115 to			B		41.315	51.547	7.138	.389	.032	.087	.270	11343
ADAC	125 ft.	385		C		44.491	55.509		.419	.035	.093	.291	12215
				A	28.960	30.725	36.857	3.458	.384	.015	.061	.307	8198
	125 to			B		43.250	51.882	4.868	.541	.022	.087	.433	11540
	133 ft.	386		C		45.463	54.537		.569	.023	.091	.455	12131
				A	35.180	27.917	33.417	3.485	.349	.014	.049	.286	7491
	137 to			B		43.069	51.554	5.377	.538	.022	.075	.441	11556
	142 ft.	387		C		45.517	54.483		.568	.023	.080	.466	12213

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 63.—Major ash constituents, Fire Gulch coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7135 6S 48E S29 ADAC	115 to 133 ft.	385-386	Cook	13.5	30.8	5.2	.2	10.7	1.4	.7	20.4	13.3	.5	96.7
	137 to 142 ft.	387		10.2	32.4	5.1	.2	8.0	5.7	.1	15.1	17.9	.5	95.2

Pawnee coal bed as shown on the Fire Gulch map (Pl. 21) was included in the report by Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

Except for approximately three-quarters of T. 6 S., R. 48 E., all the surface and the coal in the Diamond Butte, Goodspeed Butte, and Fire Gulch area are owned by the Federal Government and administered by the U.S. Forest Service, Custer National Forest. The State of Montana owns the surface and coal in sec. 16 and 36 in T. 6 S., R. 48 E. The Federal Government also has a few isolated 40-acre tracts within this township, which are administered by the U.S. Bureau of Land Management. The rest of the surface in this township is privately owned, but very little if any land in the other townships is privately owned.

SURFACE FEATURES AND LAND USE

The most prominent feature within the area is the high grass-covered divide between Powder River to the east and Otter Creek to the west. The barren tops of Diamond Butte, Goodspeed Butte, and other high points contrast sharply with the relatively flat ridges at lower levels, which have been dissected by the steep tributaries of Powder River and Otter Creek. These deeply incised valleys are separated by long ridges extending both northwest and southeast from the divide. These very steep sides of ridges are lined with lush growth of ponderosa pine trees, which are supported by clinker. The ridges are accessible from the top of the divide by trails that extend from the divide to the ends of the ridges. The valleys have a very definite northwest lineation, especially on the Powder River side of the divide.

The principal land use in the area is livestock grazing, as ranchers in the vicinity have grazing permits on Forest Service land.

GEOLOGIC STRUCTURE

Strata in the Diamond Butte, Goodspeed Butte, and Fire Gulch coal deposits dip generally southwest, except for local reversals. An anticlinal structure occurs in the southwest corner of T. 6 S., R. 47 E.

COAL BEDS

The coal beds of economic interest in the Diamond Butte, Goodspeed Butte, and Fire Gulch coal deposits are, from top to bottom, the Canyon, Cook, and Pawnee coal beds. Strippable reserves in the Canyon coal bed are shown in the Diamond Butte area (Pl. 19), strippable reserves in the Cook bed are shown in the Goodspeed Butte area (Pl. 20), and strippable reserves in the Cook and Pawnee beds are shown in the Fire Gulch coal deposit (Pl. 21). The Canyon bed is about 200 feet above the Cook bed in the Diamond Butte coal deposit (Pl. 19), sec. 30, T. 6 S., R. 47 E., as shown in drill hole SH-7124, and in drill hole SH-7134, sec. 29, T. 6 S., R. 48 E.

The Cook coal bed consists of two benches throughout the area. In drill hole SH-7124 the upper bench is 14 feet thick, the lower bench is 12 feet thick, and the parting is 34 feet. In SH-7134, however, the upper bench is 22 feet thick, the lower bench is 14 feet thick, and the parting is only 3 feet thick. Thicknesses measured in SH-7135 in sec. 29, T. 6 S., R. 48 E., are very similar to these. In drill hole SH-7121, in sec. 16, T. 6 S., R. 48 E., the Canyon bed is 211 feet above the Cook bed, and the upper bench of the Cook bed is 22 feet thick, the lower bench 12 feet, and the parting 12 feet. The parting between the two benches of the Cook seems to increase locally (Pl. 20) as shown in drill hole SH-7131, sec. 6, T. 6 S., R. 47 E. In this drill hole, the upper bench, 13 feet thick, and the lower bench, 12 feet thick, are separated by a parting of 45 feet. In drill hole SH-7133 of the same township, the upper bench, 20 feet thick, and the lower bench, 14 feet thick, are separated by a 34-foot parting.

In the Diamond Butte coal deposit, thickness of the Canyon bed ranges from 7 feet in the northern part, as measured in drill hole SH-7130 in sec. 15, T. 6 S., R. 47 E., and drill hole SH-7121 in sec. 16, T. 6 S., R. 48 E., to 16 feet in drill hole SH-7122 in sec. 34, T. 6 S., R. 47 E. The Canyon bed is easily recognizable because a coal bed 2 to 4 feet thick lies about 15 feet above it. This marker bed is noted in the mechanical logs of all the drill holes in the Diamond Butte coal deposit. The thin coal bed corresponds with a similar bed above the Canyon in the West Moorhead coal deposit farther south (Matson, 1970, p. 6).

The Pawnee coal bed and its clinker crop out at numerous localities in T. 6 S., R. 49 E. (Pl. 21). A thickness of about 20 feet was measured in sec. 5 and also in sec. 25 (Warren, 1959). Strippable reserves in the Pawnee coal bed have previously been outlined along Pinto Creek and Fire Gulch in sec. 36, T. 6 S., R. 48 E., and sec. 19, 20, 30, and 31, T. 6 S., R. 49 E. (Ayler, Smith, and Deutman, 1969). Other strippable reserves of the Pawnee have been outlined along Cache Creek in sec. 1, T. 6 S., R. 48 E., and sec. 6 and 7, T. 6 S., R. 49 E. (Matson, Dahl, and Blumer, 1968).

COAL QUALITY

Twelve core samples were obtained during the current project and were analyzed by the Montana Bureau of

Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value for the Diamond Butte coal deposit are shown in Table 58, for Goodspeed Butte in Table 60, and for Fire Gulch in Table 62. Analytical results of composite samples showing ash constituents are shown in Tables 59, 61, and 63.

Although no cores were obtained from the Pawnee coal bed in the Fire Gulch coal deposit on this project, a core taken previously was reported by Matson, Dahl, and Blumer (1968). This core sample was obtained in sec. 36, T. 5 S., R. 48 E., and on the "as received" basis, shows a moisture content of 32.0%, volatile matter 29.5%, fixed carbon 32.5%, ash 6%, sulfur 0.2%, hydrogen 6.7%, carbon 45.4%, nitrogen 0.8%, oxygen 40.9%, heating value 7,650 Btu.

COAL RESERVES

The Goodspeed Butte coal deposit has reserves in the Cook coal bed totaling 628,950,000 tons, the Diamond Butte coal deposit has reserves in the Canyon coal bed totaling 418,020,000 tons, and the Fire Gulch coal deposit has reserves of 336,690,000 tons in the Cook and Pawnee coal beds (Table 57).

SWEENEY CREEK-SNYDER CREEK COAL DEPOSIT

LOCATION

The Sweeney Creek-Snyder Creek coal deposit (Pl. 22) is in T. 2 and 3 N., R. 43 and 44 E., Rosebud County. The deposit is on the divide between Rosebud Creek on the west and Tongue River on the east, and is about 20 miles south of the Yellowstone River.

FIELD WORK AND MAP PREPARATION

The field work in the Sweeney Creek-Snyder Creek area was completed in the summer of 1968 under a cooperative agreement between the Montana Bureau of Mines and Geology and Burlington Northern, Inc. The purpose was to gain new information on the quality and quantity of coal resources in strippable coal fields in southeastern Montana. The Bureau and the railroad each provided part of the evaluation cost.

The field work was conducted under the supervision of Loren Williams assisted by Peter Mattson of Burlington Northern, Inc., and Gardar G. Dahl, Montana Bureau of Mines and Geology. The field method utilized was developed by Burlington Northern, Inc. (Carmichael, 1967).

PREVIOUS GEOLOGIC WORK

The geology of the Sweeney Creek-Snyder Creek coal deposit was described in a U.S. Geological Survey report on the Rosebud coal field (Pierce, 1936). The strippable coal was also outlined and discussed in the report by Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

The Sweeney Creek-Snyder Creek coal deposit lies within the land grant to Burlington Northern, Inc. The railroad has retained ownership of mineral rights in the odd-numbered sections but has conveyed the surface. The Federal Government retained the coal rights when it conveyed the even-numbered sections. The State of Montana owns the surface and minerals in sec. 16 and 36 of each township.

SURFACE FEATURES AND LAND USE

The divide between Tongue River and Rosebud Creek has a fairly flat top and is bordered by clinker formed by burning of the Terret coal bed. The rugged slopes of the sharp and deep valleys on both sides of the divide are covered with ponderosa pine. The principal land use in the area is livestock grazing.

Table 64.–Reserves, overburden, overburden ratio, acres, and tons/acre, Sweeney Creek-Snyder Creek coal deposit.

TERRET BED

Thickness of overburden, ft.		Indicated reserves, million tons		Overburden, million cu. yd.		Overburden ratio, cubic yards/ton		Acres		Tons/acre
0 to 50		169.35		298.96		1.77		5,614.5		30,162.4
50 to 100		147.03		599.3		4.08		4,952.7		29,686.8
100 to 150		9.95		71.32		7.17		353.9		28,106.8
	Total	326.33	Total	969.58	Average	2.97	Total	10,921.1	Average	29,880.4

Table 65.–Proximate analysis, ultimate analysis, forms of sulfur, and heating value, Sweeney Creek-Snyder Creek coal deposit.

Drill hole and location	Depth sampled	Lab. and sample no.	Coal bed	Form of analysis 1/	Proximate, % Moisture	Proximate, % Volatile matter	Proximate, % Fixed carbon	Proximate, % Ash	Ultimate, % S	Ultimate, % H	Ultimate, % C	Ultimate, % N	Ultimate, % O	Heating value (Btu)	Form of sulfur, % Sulfur	Form of sulfur, % Sulfate	Form of sulfur, % Pyritic	Form of sulfur, % Organic
SS-1C		J-11591	Terret	A	23.91	27.91	39.03	9.15	1.53	5.77	49.62	.81	33.12	8310	1.53	.07	1.13	.34
2N 44E S29	50 to			B		33.68	51.30	12.02	2.01	4.08	65.22	1.07	15.60	10930	2.01	.09	1.48	.44
CABC	66 ft.	GF-69-36		C		41.69	58.31		2.29	4.64	74.13	1.22	17.72	12420	2.29	.10	1.69	.50
SS-2C		J-11592	Terret	A	24.63	27.79	38.44	9.14	1.12	5.82	48.95	.82	34.15	8200	1.12	.08	.77	.28
2N 44E S4	74 to			B		36.87	51.00	12.13	1.49	4.10	64.95	1.08	16.25	10870	1.49	.10	1.02	.37
CADA	92 ft.	GF-69-37		C		41.96	58.04		1.69	4.67	73.92	1.23	18.49	12370	1.69	.11	1.16	.42
SS-3C		J-11593	Terret	A	24.53	28.28	37.92	9.27	.94	5.78	49.04	.81	34.16	8170	.94	.03	.58	.33
3N 44E S27	80 to			B		37.47	50.25	12.28	1.24	4.06	64.97	1.07	16.38	10830	1.24	.04	.77	.43
CCBB	97½ ft.	GF-69-38		C		42.72	57.28		1.42	4.62	74.07	1.22	18.67	12350	1.42	.05	.88	.49
SS-5C		J-11594	Terret	A	25.31	28.27	36.99	9.43	1.18	5.87	48.45	.80	34.27	8020	1.18	.05	.92	.21
3N 44E S3	109 to			B		37.86	49.52	12.62	1.59	4.09	64.87	1.07	15.76	10740	1.59	.07	1.23	.29
DAAA	127 ft.	GF-69-39		C		43.33	56.67		1.82	4.68	74.24	1.23	18.03	12290	1.82	.08	1.41	.33

1/A, as received; B, moisture free; C, moisture and ash free.

Table 66.–Major ash constituents and fusibility of ash, Sweeney Creek-Snyder Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, % Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total	Fusibility of ash, °F Initial deformation temp.	Softening temp.	Fluid temp.	Real specific gravity
SS-1C 2N 44E S29 CABC	50 to 66 ft.	GF-69-36	Terret	15.4	13.0	19.0	.2	3.2	1.3	.9	26.7	17.4	.8	97.9	1910	1940	1970	1.59
SS-2C 2N 44E S4 CADA	74 to 92 ft.	GF-69-37	Terret	16.2	13.3	13.8	.3	4.1	2.7	.4	30.5	16.2	.4	97.9	1900	1940	1980	1.58
SS-3C 3N 44E S27 CCBB	80 to 97½ ft.	GF-69-38	Terret	13.8	16.9	12.8	.3	4.1	1.7	.3	27.2	21.5	.4	99.0	1930	1970	2010	1.56
SS-5C 3N 44E S3 DAAA	109 to 127 ft.	GF-69-39	Terret	13.7	16.6	14.4	.2	5.5	.4	.3	27.0	21.4	.5	100.0	1940	1970	2000	1.59

GEOLOGIC STRUCTURE

The strata in the Sweeney Creek-Snyder Creek coal deposit, although nearly horizontal, show a gentle southerly dip.

A fault, mapped in sec. 1, T. 3 N., R. 44 E., has a strike of N. 30° W. and a maximum throw of 60 feet. The southwest side of the fault is downdropped (Pierce, 1936, pl. 1).

COAL BEDS

The Terret coal bed is the only one that contains strippable reserves in the Sweeney Creek-Snyder Creek coal deposit. The Burley bed, below the Terret bed, is generally thin throughout the area (Pierce, 1936), and it is 4 feet thick in drill hole SS-1C in sec. 29, T. 2 N., R. 44 E. The Terret coal bed, 17 to 18 feet thick throughout the area, has burned along the sides of the ridge.

COAL QUALITY

Four core samples of the Terret coal bed were obtained and analyzed by the U.S. Bureau of Mines Coal Research Laboratory at Grand Forks. Proximate analysis, ultimate analysis, heating value, and forms of sulfur are shown in Table 65. Major ash constituents, fusibility of ash, and specific gravity are shown in Table 66.

COAL RESERVES

Reserves in the Terret coal bed total 326,330,000 tons (Table 64).

Table 67.—Reserves, overburden, overburden ratio, acres, and tons/acre, Yager Butte coal deposit.

ELK and DUNNING BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	442.35	836.6	1.89	11,116.4	39,793.9
50 to 100	417.60	1,567.35	3.75	9,689.2	43,100.4
100 to 150	315.91	1,361.27	4.30	6,118.4	51,632.8
	Total 1,175.86	Total 3,765.22	Average 3.20	Total 26,924.0	Average 43,673.3

COOK BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	53.19	156.71	2.95	2,943.4	18,070.94
50 to 100	112.72	688.75	6.11	5,692.0	19,803.23
100 to 150	146.11	1,182.31	8.09	5,872.1	24,882.07
	Total 312.02	Total 2,027.77	Average 6.50	Total 14,507.5	Average 21,507.50

YAGER BUTTE COAL DEPOSIT

LOCATION

The Yager Butte coal deposit (Pl. 23A and B) is in T. 3, 4, and 5 S., R. 46 and 47 E., Powder River County. The area is bordered on the south by the Diamond Butte (Pl. 19), the Goodspeed Butte (Pl. 20), and the Fire Gulch (Pl. 21) coal fields. The area is overlapped on the east by the Threemile Buttes (Pl. 24) and by the Sonnette (Pl. 25A and B) coal fields. On the north it adjoins the Ashland coal field (Pl. 13) and on the west the Otter Creek coal field (Pl. 12). The area is on the west side of the high divide between Pumpkin Creek to the east and Otter Creek to the west.

FIELD METHODS AND MAP PREPARATION

Field work in the Yager Butte area, done in 1970 and 1971, included drilling numerous exploration holes and

Table 68.–Proximate analysis, forms of sulfur, and heating value, Yager Butte coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7047 5S R47E S29 CAAA	141 to 151 ft.	240	Cook	A	35.550	27.143	33.130	4.177	.442	.029	.159	.253	7412
				B		42.114	51.404	6.482	.685	.045	.247	.393	11501
				C		45.033	54.967		.733	.048	.264	.420	12298
	151 to 156 ft.	241		A	35.370	27.995	32.805	3.830	.263	.014	.014	.234	7359
				B		43.316	50.759	5.926	.407	.022	.022	.363	11386
				C		46.044	53.956		.432	.023	.023	.386	12104
	156 to 158 ft.	242		A	29.350	27.832	22.121	20.697	1.767	.076	1.135	.556	5881
				B		39.394	31.311	29.295	2.501	.108	1.606	.787	8324
				C		55.716	44.284		3.537	.152	2.271	1.113	11773
SH-7048 5S R46E S25 CDDC	62 to 72 ft.	243	Cook	A	32.430	34.371	26.561	6.638	.672	.034	.319	.319	7496
				B		50.868	39.308	9.824	.995	.051	.472	.472	11093
				C		56.409	43.591		1.104	.057	.523	.523	12302
	72 to 76 ft.	244		A	32.560	30.931	32.785	3.724	.465	.000	.000	.465	7541
				B		45.865	48.614	5.522	.690	.000	.000	.690	11182
				C		48.545	51.455		.731	.000	.000	.731	11835
SH-7050 5S R47E S4 AADD	86 to 94 ft.	249	Elk	A	35.980	28.050	31.304	4.666	.340	.014	.092	.234	7125
				B		43.814	48.898	7.288	.532	.022	.144	.365	11130
				C		47.258	52.742		.573	.024	.155	.394	12005
SH-7137 5S R47E S22 ADCC	50 to 60 ft.	388	Cook	A	32.930	28.761	34.474	3.835	.320	.007	.051	.262	7703
				B		42.882	51.400	5.718	.477	.011	.076	.391	11484
				C		45.483	54.517		.506	.012	.081	.414	12181
	115 to 118 ft.	389		A	34.230	27.568	34.093	4.109	.540	.014	.149	.377	7386
				B		41.915	51.837	6.247	.821	.022	.227	.573	11230
				C		44.708	55.292		.876	.023	.242	.611	11978
SH-7144 5S R46E S15 BDCA	92 to 98 ft.	395	Elk	A	33.570	26.447	36.282	3.701	.331	.022	.000	.310	7687
				B		39.811	54.617	5.571	.499	.033	.000	.466	11572
				C		42.160	57.840		.528	.034	.000	.494	12254
	98 to 102 ft.	396		A	31.750	28.822	35.890	3.538	.271	.022	.007	.242	7852
				B		42.230	52.586	5.184	.397	.032	.011	.354	11505
				C		44.539	55.461		.419	.034	.011	.374	12134
SH-7145 4S R46E S19 DDAA	38 to 43 ft.	397	Elk	A	33.130	27.520	35.562	3.788	.208	.029	.014	.165	7702
				B		41.154	53.181	5.664	.312	.043	.021	.247	11518
				C		43.625	56.375		.330	.046	.023	.262	12209

SH-7145 4S R46E S19 DDAA	43 to 48 ft.	398	Elk	A	30.610	27.907	34.004	7.478	.535	.037	.119	.379	7575
				B		40.218	49.005	10.777	.771	.054	.171	.546	10916
				C		45.076	54.924		.864	.060	.192	.612	12235
SH-7146 4S R46E S20 CABC	30 to 35 ft.	399	Elk	A	31.120	27.753	34.676	6.452	.435	.044	.096	.295	7515
				B		40.291	50.343	9.366	.632	.064	.139	.428	10910
				C		44.455	55.545		.697	.071	.154	.472	12037
	35 to 40 ft.	400		A	30.880	29.031	35.618	4.471	.222	.022	.015	.185	7943
				B		42.000	51.531	6.468	.321	.032	.021	.268	11492
				C		44.905	55.095		.343	.034	.023	.286	12286
	100 to 106 ft.	401	Dunning	A	30.060	29.067	35.064	5.809	.225	.015	.000	.210	7817
				B		41.560	50.134	8.306	.322	.021	.000	.300	11177
				C		45.325	54.675		.351	.023	.000	.327	12189
	106 to 110 ft.	402		A	30.170	29.219	36.255	4.356	.210	.015	.000	.195	7991
				B		41.844	51.919	6.238	.300	.021	.000	.279	11444
				C		44.627	55.373		.320	.023	.000	.297	12205
SH-7148 4S R46E S23 DBCB	51 to 54 ft.	403	Local	A	32.260	28.593	34.478	4.669	.760	.043	.123	.594	7722
				B		42.210	50.898	6.892	1.122	.064	.182	.876	11400
				C		45.335	54.665		1.205	.069	.195	.941	12244
SH-7149 4S R46E S14 CADC	43 to 52 ft.	404	Dunning	A	28.590	30.188	36.350	4.872	.229	.000	.053	.176	8005
				B		42.274	50.904	6.823	.321	.000	.075	.246	11209
				C		45.369	54.631		.344	.000	.080	.264	12030
	52 to 54 ft.	405		A	33.810	28.190	33.398	4.602	.395	.014	.120	.261	7445
				B		42.589	50.459	6.952	.597	.021	.181	.395	11248
				C		45.771	54.229		.642	.023	.195	.424	12088
SH-7150 4S R47E S7 CBBD	31 to 33 ft.	406	Elk	A	33.760	28.172	33.020	5.047	.284	.021	.028	.235	7297
				B		42.531	49.850	7.620	.429	.032	.043	.354	11016
				C		46.039	53.961		.465	.035	.046	.383	11925
	33 to 41 ft.	407		A	33.170	28.568	33.162	5.100	.250	.029	.036	.185	7371
				B		42.747	49.621	7.632	.374	.043	.053	.278	11030
				C		46.279	53.721		.404	.046	.058	.300	11941

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[1] A, as received; B, moisture free; C, moisture and ash free.

Table 69.—Major ash constituents, Yager Butte coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7047 5S 47E S29 CAAA	141 to 158 ft.	240-242	Cook	18.2	7.8	9.3	2.9	4.0	.4	.2	45.9	10.6	.5	99.8
SH-7048 5S 46E S25 CDDC	62 to 76 ft.	243-244	Cook	13.3	22.3	8.7	.2	6.7	2.9	.4	23.6	19.1	.5	97.7
SH-7050 5S 47E S4 AADD	86 to 94 ft.	249	Elk	12.5	33.9	6.2	.2	8.5	2.9	3.1	9.6	17.3	.4	94.6
SH-7137 5S 47E S22 ADCC	50 to 60 ft.	388	Cook	8.0	32.6	5.3	.1	9.9	.6	.2	19.7	14.8	.4	91.6
	115 to 118 ft.	389		11.1	28.1	9.3	.2	6.4	6.2	1.1	9.9	23.7	.3	96.3
SH-7144 5S 46E S15 BDCA	92 to 102 ft.	395-396	Elk	10.6	24.9	6.3	.1	13.2	.7	.7	21.7	15.1	.6	93.9
SH-7145 4S 46E S19 DDAA	38 to 48 ft.	397-398	Elk	13.1	17.8	5.5	.8	4.7	8.7	.4	31.2	13.7	.6	96.5
SH-7146 4S 46E S20 CABC	30 to 40 ft.	399-400	Elk	12.7	19.9	5.1	.7	6.6	4.5	.4	35.4	8.8	.8	94.9
	100 to 110 ft.	401-402	Dunning	18.4	19.2	4.7	.2	6.5	4.6	.6	31.6	9.0	1.1	95.9
SH-7148 4S 46E S23 DBCB	51 to 54 ft.	403	Local	13.4	15.7	8.8	.5	9.1	2.0	.1	21.5	21.7	.5	93.3
SH-7149 4S 46E S14 CADC	43 to 54 ft.	404-405	Dunning	18.0	23.6	4.4	.2	6.6	4.6	.2	25.6	8.9	.9	93.0
SH-7150 4S 47E S7 CBBD	31 to 41 ft.	406-407	Elk	15.2	20.1	4.8	.2	9.9	1.3	.4	33.7	9.5	1.2	96.3

mapping the surface on black-and-white aerial photos or on 7½-minute topographic quadrangle maps. Color photos of the Custer National Forest obtained from the U.S. Forest Service were used to complete the mapping of coal outcrop and burn lines.

PREVIOUS GEOLOGIC WORK

The Yager Butte coal deposit is included in the report on the Birney-Broadus coal field (Warren, 1959).

LAND OWNERSHIP

Most of the Yager Butte coal deposit is within the boundaries of the Custer National Forest, which is administered by the U.S. Forest Service, but a small portion in T. 5 S., R. 47 E., lies outside the forest boundary. The Federal Government has retained ownership of all the coal, however.

SURFACE FEATURES AND LAND USE

The surface features in the Yager Butte coal deposit consist of a broad rolling upland area that forms the divide between Pumpkin Creek to the east and Otter Creek to the west and breaks into precipitous slopes along the valleys of Elk Creek, Fifteenmile Creek, Tenmile Creek, and Threemile Creek. The burning of coal beds in the area has created thick masses of multicolored clinker that form resistant capping along the ridge sides. The ridges between the tributaries of Otter Creek are relatively flat and grass covered, and the sides support lush growths of ponderosa pine and other vegetation. These tributaries contain water in pools the year round but they flow only during periods of heavy precipitation or spring runoff.

The principal land use in the area is livestock grazing. Many nearby ranchers have grazing permits in the National Forest.

GEOLOGIC STRUCTURE

The strata in the Yager Butte coal deposit seem to be nearly horizontal but show a very slight southwesterly dip.

COAL BEDS

Coal beds in the Yager Butte coal deposit that contain economically strippable reserves are, from top to bottom, the Cook, Elk, and Dunning beds. Strippable reserves in the Elk and Dunning coal beds are shown on Plate 23A and those in the Cook bed on Plate 23B. The Wall coal bed has been identified in the northern part of the area (Pl. 34).

The Cook coal bed in the Yager Butte coal deposit is in two benches 30 to 66 feet apart. In drill hole SH-7136, sec. 33, T. 5 S., R. 47 E., the upper bench of the Cook is 19 feet thick, the lower bed is 11 feet thick, and the two benches are 30 feet apart. In that same drill hole, a higher coal bed 6 feet thick is identified as the Canyon coal bed. To the north and northwest, the Cook beds thin. In drill hole SH-7138, sec. 17, T. 5 S., R. 47 E., the upper bench is 6 feet thick, the lower bench is 9 feet, and the parting is 66 feet. In drill hole SH-7139, sec. 15 of the same township, the upper bench of the Cook is 5 feet thick, the lower bench is 8 feet, and the parting is 30 feet. The upper bench of the Cook is missing farther north.

The Wall coal bed, 11 feet thick, is 72 to 130 feet below the Cook bed in the mapped area. The Elk and Dunning coal beds, shown on Plate 23A, have large reserves within the mapped area. The Elk bed is 23 feet above the Dunning bed in drill hole SH-7144, sec. 15, T. 5 S., R. 46 E., and 39 feet above it in an oil well in sec. 28, T. 4 S., R. 47 E. The Elk bed is 10 feet thick in an oil well in sec. 28 (cross section, Pl. 34) and is 21 feet thick in drill hole SH-7145 in sec. 19, T. 4 S., R. 46 E. Thickness of the Dunning bed ranges from 14 feet in drill holes SH-7145 and SH-7146 to 20 feet in the oil well in sec. 28.

COAL QUALITY

Twenty-one core samples were obtained during the field evaluation and were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating values are shown in Table 68, and major ash constituents are shown in Table 69.

COAL RESERVES

The indicated coal reserves in the Elk and Dunning coal beds are 1,175,860,000 tons, and in the Cook bed they are 312,020,000 tons. Total reserves in the Yager Butte coal deposit are 1,487,880,000 tons (Table 67).

SONNETTE AND THREEMILE BUTTES COAL DEPOSITS

LOCATION

The Sonnette area is in T. 3, 4, 5, and 6 S., R. 47, 48, and 49 E., Powder River County. The maps outlining the strippable coal in the Sonnette area include the Threemile Buttes (Pl. 24) and the Sonnette (Pl. 25A and B) coal deposits, which are discussed together because of the large amount of overlap in the two deposits. The area is joined on the north by the Pumpkin Creek coal deposit (Pl. 15), on the northwest it borders the Home Creek Butte coal deposit (Pl. 26), and on the south it borders the Diamond Butte (Pl. 19), Goodspeed Butte (Pl. 20), and Fire Gulch (Pl. 21) coal deposits. In the northwest corner of T. 4 S., R. 47 E., the area borders the Ashland coal deposit (Pl. 13A and B).

FIELD WORK AND MAP PREPARATION

Reconnaissance field work in the area in 1967 included the drilling of one hole in sec. 16, T. 5 S., R. 48 E. Additional holes were drilled during the 1971 field season to explore the Cook, Canyon, and Ferry coal beds, and part of the area was mapped on black-and-white aerial photos. During the winter of 1972, the mapping was refined by use of colored aerial photos borrowed from the U.S. Forest Service. Field data were plotted on U.S. Geological Survey 7½-minute topographic quadrangle maps.

PREVIOUS GEOLOGIC WORK

The Sonnette area was included in the U.S. Geological Survey report on the Birney-Broadus coal field (Warren, 1959). Strippable coal in the Pawnee bed was outlined in Montana Bureau of Mines and Geology Bulletin 69 (Matson, Dahl, and Blumer, 1968).

LAND OWNERSHIP

The Sonnette area borders the Custer National Forest, and the Threemile Buttes coal deposit (Pl. 24) overlaps onto the forest. East of the forest boundary, the ownership is mixed; the State of Montana owns sec. 16 and 36 in each township, and the rest of the surface is privately owned. The area is within the land grant to Burlington Northern, Inc., and in T. 4 S., R. 48 E., and the eastern part of T. 4 S., R. 47 E., the railroad owns the coal in odd-numbered sections, but T. 5 S. is south of the railroad land grant, and most of the coal there is federally owned.

SURFACE FEATURES AND LAND USE

The most prominent surface feature in the Sonnette area is the Pumpkin Creek valley. Near Sonnette the creek turns abruptly from east to north and flows northward to join the Tongue River in T. 6 N., R. 48 E. The burning of the Cook coal bed has formed resistant clinker that supports flat-topped benches and ridges and steep valley sides.

The valley sides are covered by ponderosa pine, but the ridgetops are barren except for native grasses. Pumpkin Creek is an intermittent stream, which flows only during periods of heavy precipitation or spring runoff, although ponds persist throughout the year. The valley is ½ to 1 mile wide throughout most of its length in the area. Most of its tributaries are short and steep except in the southern part of the area. Numerous roads traverse the eastern and southern part of the area. Sonnette Post Office is in sec. 8, T. 5 S., R. 48 E.

Although the principal land use in the area is livestock grazing, numerous fields are cultivated along the bottom of Pumpkin Creek valley. In other parts of the area where topographic conditions permit, winter wheat and other grains are raised on summer fallowed tracts. Grazing permits on the National Forest are allotted to nearby ranchers.

GEOLOGIC STRUCTURE

All the streams within the Sonnette area seem to be structurally controlled. The most prominent streams and ridge lines show definite northwest-southeast trends.

Drill data of the Pawnee coal bed show that the strata dip gently to the southwest but reversals are numerous. A structural depression in sec. 7, 8, and 17, T. 4 S., R. 48 E., trends northwest. A structurally high area is mapped in the northeast corner of T. 5 S., R. 48 E.

COAL BEDS

Coal beds of economic importance in the Sonnette area include, from lowest to highest, the Pawnee, Cook, Ferry, and Canyon beds, all of which have adequate thickness and quality for economical stripping. The Pawnee coal bed crops out along the sides of the Pumpkin Creek valley in the western half of T. 4 S., R. 48 E., but passes beneath alluvium in sec. 33. The greatest thickness of the Pawnee is 22 feet, measured in drill hole SS-4, sec. 16, T. 5 S., R. 48 E. In drill hole SH-7114, sec. 20, T. 4 S., R. 48 E., a 2-foot parting splits the bed into an upper bench 12 feet thick and a lower bench 10 feet thick. To the east and south, the Pawnee bed maintains a thickness of 20 feet as far as the Fire Gulch coal deposit (Pl. 21) as it is that thick in drill hole SS-3, sec. 36, T. 5 S., R. 48 E. Inferred reserves in the Pawnee coal bed are shown on the east side of the mapped area, which is beyond the area shown on adequate topographic maps. These reserves extend south into Cache Creek in the northwest corner of T. 6 S., R. 49 E. Indicated reserves in the Pawnee coal bed are mapped along the sides and bottom of Pumpkin Creek valley and back of the outcrop along the east side of the divide extending to sec. 36, T. 4 S., R. 48 E.

Strippable reserves in the Cook coal bed (Pl. 25B), which lies about 170 to 200 feet above the Pawnee bed, cover a large area in the vicinity of Sonnette. Clinker

Table 70.—Reserves, overburden, overburden ratio, acres, and tons/acre, Sonnette and Threemile Buttes coal deposits.

COOK BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	84.23	228.88	2.72	3,027.2	27,826.2
50 to 100	125.73	591.60	4.71	3,795.2	33,130.4
100 to 150	100.09	616.40	6.16	2,464.0	40,620.9
150 to 200	52.93	399.15	7.54	1,184.0	44,704.4
	Total 362.98	Total 1,836.03	Average 5.06	Total 10,470.4	Average 34,668.6

PAWNEE BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	92.46	126.41	1.36	2,374.4	38,940.4
50 to 100	125.11	388.75	3.10	3,212.8	38,941.1
100 to 150	102.68	531.58	5.18	2,636.8	38,941.1
	Total 320.25	Total 1,046.74	Average 3.26	Total 8,224.0	Average 38,940.9

Thickness of overburden, ft.	Inferred reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
100 to 150	183.06	1,042.74	5.69	5,171	35,401.3

Thickness of overburden, ft.	Total reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	92.46	126.41	1.36	2,374.4	38,940.4
50 to 100	125.11	388.75	3.10	3,212.8	38,941.1
100 to 150	285.74	1,574.28	5.50	7,807.8	36,596.7
	Total 503.31	Total 2,089.44	Average 4.15	Total 13,395.0	Average 37,574.5

CANYON and FERRY BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	107.99	360.43	3.33	6,764.8	15,963.5
50 to 100	96.48	733.87	7.60	6,060.8	15,918.7
100 to 150	20.93	204.12	9.75	1,011.2	20,698.2
	Total 225.40	Total 1,298.42	Average 5.76	Total 13,836.8	Average 16,289.7

Table 71.–Proximate analysis, forms of sulfur, and heating value, Sonnette coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7114 4S 48E S20 ABAB	70 to 80 ft.	362	Pawnee	A	34.410	26.826	34.343	4.421	.149	.016	.000	.133	7364
				B		40.899	52.360	6.741	.227	.024	.000	.203	11227
				C		43.855	56.145		.243	.026	.000	.218	12039
	80 to 90 ft.	363		A	33.120	24.964	29.299	12.617	1.042	.016	.286	.740	6624
				B		37.326	43.809	18.865	1.558	.024	.428	1.106	9904
				C		46.005	53.995		1.921	.029	.528	1.363	12206
	90 to 95 ft.	364		A	36.240	25.653	32.007	6.099	.306	.007	.022	.277	6936
				B		40.234	50.199	9.566	.481	.012	.035	.434	10878
				C		44.491	55.509		.532	.013	.039	.480	12029
SH-7115 4S 48E S34 DABD	40 to 50 ft.	365	Pawnee	A	36.280	26.568	33.275	3.877	.191	.023	.023	.145	7228
				B		41.695	52.220	6.085	.300	.036	.036	.228	11343
				C		44.396	55.604		.319	.038	.038	.243	12078
	50 to 56 ft.	366		A	31.970	27.555	30.793	9.682	.368	.337	.024	.008	7138
				B		40.505	45.264	14.231	.542	.496	.035	.012	10492
				C		47.226	52.774		.631	.578	.040	.013	12233
SH-7116 4S 48E S29 CCAD	30 to 37 ft.	367	Pawnee	A	36.370	26.361	30.343	6.925	1.400	.030	.640	.730	7902
				B		41.429	47.687	10.884	2.200	.047	1.006	1.148	12418
				C		46.489	53.511		2.469	.053	1.128	1.288	13935
	190 to 192 ft.	372		A	28.980	23.128	22.577	25.315	2.731	.024	1.432	1.275	5556
				B		32.565	31.789	35.645	3.845	.033	2.017	1.795	7824
				C		50.603	49.397		5.975	.052	3.134	2.789	12157
SH-7117 5S 48E S7 BCAA	72 to 82 ft.	368	Cook	A	35.000	25.786	32.714	6.500	.736	.024	.190	.523	7186
				B		39.671	50.329	10.000	1.133	.037	.292	.804	11055
				C		44.079	55.921		1.259	.041	.325	.893	12283
	114 to 119 ft.	369		A	34.380	26.656	29.997	8.967	1.655	.031	.659	.966	7000
				B		40.621	45.714	13.665	2.523	.047	1.004	1.472	10668
				C		47.051	52.949		2.922	.054	1.163	1.705	12357
SH-7118 5S 48E S22 DCDA	38 to 41 ft.	370	Canyon	A	36.960	26.709	30.054	6.277	.955	.022	.235	.698	6904
				B		42.369	47.674	9.957	1.516	.035	.373	1.108	10951
				C		47.054	52.946		1.683	.039	.414	1.230	12162
	78 to 86 ft.	371	Cook	A	38.680	25.665	30.111	5.544	.842	.023	.181	.639	6818
				B		41.855	49.105	9.041	1.374	.037	.294	1.043	11119
				C		46.015	53.985		1.510	.040	.324	1.146	12224
SH-7120 4S 48E S36 CCCC	70 to 72 ft.	375	Cook	A	33.740	26.688	26.224	13.348	1.995	.037	.967	.990	6547
				B		40.278	39.577	20.145	3.010	.057	1.460	1.494	9881
				C		50.439	49.561		3.770	.071	1.828	1.871	12374

1/A, as received; B, moisture free; C, moisture and ash free.

Table 72.—Major ash constituents, Sonnette coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7114 4S 48E S20 ABAB	70 to 95 ft.	362-364	Pawnee	22.8	14.1	4.8	.6	4.2	6.3	.4	33.7	10.6	.7	98.2
SH-7115 4S 48E S34 DABD	40 to 56 ft.	365-366	Pawnee	19.1	21.3	4.2	.2	7.4	.9	.4	34.8	7.9	.9	97.1
SH-7116 4S 48E S29 CCAD	30 to 37 ft.	367	Pawnee	10.1	22.5	10.8	.2	2.3	.7	.2	16.5	27.4	.3	91.0
	190 to 192 ft.	372	Pawnee	17.7	3.4	10.4	3.0	2.3	.8	.1	50.3	5.2	.7	93.9
SH-7117 5S 48E S7 BCAA	72 to 82 ft.	368	Cook	11.7	21.7	8.2	.4	5.5	7.2	.1	18.7	21.4	.4	95.3
	114 to 119 ft.	369	Cook	13.5	15.4	11.8	.5	3.7	4.0	.2	22.7	22.2	.4	94.4
SH-7118 5S 48E S22 DCDA	38 to 41 ft.	370	Canyon	11.7	22.0	9.6	.4	5.7	2.5	1.3	19.2	22.3	.4	95.1
	78 to 86 ft.	371	Cook	11.5	24.2	7.9	.4	6.9	2.4	.8	18.7	23.5	.3	96.6
SH-7120 4S 48E S36 CCCC	70 to 72 ft.	375	Cook	17.3	8.2	12.4	.6	3.4	.2	.4	45.3	5.9	.9	94.6

Table 73.–Proximate analysis, forms of sulfur, and heating value, Threemile Buttes coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis [1]	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7118 5S R48E S22 DCDA	38 to 41 ft.	370	Canyon	A	36.960	26.709	30.054	6.277	.955	.022	.235	.698	6904
				B		42.369	47.674	9.957	1.516	.035	.373	1.108	10951
				C		47.054	52.946		1.683	.039	.414	1.230	12162
SH-7141 4S R47E S35 CBBA	45 to 52 ft.	392	Canyon	A	36.820	27.686	31.204	4.290	.451	.027	.061	.362	7080
				B		43.821	49.389	6.790	.714	.043	.097	.573	11206
				C		47.013	52.987		.766	.046	.104	.615	12022
SH-7142 4S R47E S23 CBBA	42 to 50 ft.	393	Canyon	A	38.100	26.517	31.527	3.856	.389	.034	.067	.288	6904
				B		42.839	50.932	6.230	.628	.054	.108	.466	11153
				C		45.685	54.315		.670	.058	.116	.497	11894
SH-7151 4S R47E S4 CADD	90 to 91 ft.	408	Canyon	A	36.390	25.199	29.716	8.695	2.547	.084	1.520	.943	6716
				B		39.615	46.715	13.670	4.004	.133	2.389	1.482	10559
				C		45.888	54.112		4.637	.154	2.767	1.717	12230
	91 to 93 ft.	409		A	38.230	26.227	29.894	5.649	.988	.020	.291	.676	6688
				B		42.460	48.396	9.145	1.599	.033	.471	1.095	10828
				C		46.733	53.267		1.760	.036	.518	1.205	11918
	93 to 100 ft.	410		A	38.680	25.684	29.962	5.674	.658	.054	.108	.495	6646
				B		41.886	48.861	9.253	1.072	.088	.177	.807	10838
				C		46.157	53.843		1.182	.097	.195	.889	11943
SH-7152 3S R47E S33 CBAB	54 to 57 ft.	411	Canyon	A	36.190	26.627	32.516	4.667	.604	.022	.230	.352	7133
				B		41.729	50.958	7.314	.947	.034	.361	.552	11179
				C		45.021	54.979		1.021	.036	.389	.596	12061

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[1] A, as received; B, moisture free; C, moisture and ash free.

Table 74.—Major ash constituents, Threemile Buttes coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7118 5S 48E S22 DCDA	38 to 41 ft.	370	Canyon	11.7	22.0	9.6	.4	5.7	2.5	1.3	19.2	22.3	.4	95.1
SH-7141 4S 47E S35 CBBA	45 to 52 ft.	392	Canyon	8.9	34.2	5.8	.2	9.0	1.0	1.5	17.1	19.1	.4	97.2
SH-7142 4S 47E S23 CBBA	42 to 50 ft.	393	Canyon	8.9	28.7	7.5	.2	12.9	2.0	1.0	14.6	19.3	.4	95.5
SH-7151 4S 47E S4 CADD	90 to 100 ft.	408-410	Canyon	9.5	20.1	9.8	.1	6.5	2.4	2.2	11.2	27.8	.3	89.9
SH-7152 3S 47E S33 CBAB	54 to 57 ft.	411	Canyon	7.1	23.8	9.8	.2	15.0	.7	.1	15.4	24.0	.4	96.5

formed where it burned produces very steep ridges on the sides of Pumpkin Creek valley. The coal bed consists of two benches 22 feet apart at the north and about 40 feet at the southeast side of the mapped area. The upper bench is 10 feet thick as measured in drill hole SH-7117 and 16 feet in SH-7119 in sec. 12, T. 5 S., R. 48 E. The lower bench is 6 feet thick in SH-7119 and 10 feet in drill hole SH-7117.

About 50 feet above the Cook beds is the Ferry coal bed, and 50 to 100 feet higher is the Canyon coal bed, which consists of two benches in T. 5 S., R. 47 and 48 E., shown on the Threemile Buttes coal deposit (Pl. 24). In drill hole SH-7121, sec. 16, T. 6 S., R. 48 E., in the Diamond Butte coal deposit (Pl. 19), the Canyon is a single bed 7 feet thick, and in SH-7136 in sec. 33, T. 5 S., R. 47 E., it is 6 feet thick. One bench of the Canyon bed thickens northward and in SH-7141 in sec. 35, T. 4 S., R. 47 E., it is 13 feet thick. In drill hole SH-7143, sec. 15, the upper bench is 4 feet thick and the lower bench 13 feet.

The Ferry coal bed is thin and discontinuous in the southern part of the area, but in the northern part it is 17 feet thick in drill hole SH-7152, sec. 33, T. 3 S., R. 47 E., and 13 feet thick in drill hole SH-7151, sec. 4, T. 4 S., R. 47 E. In drill hole SH-7142, sec. 23, T. 4 S., R. 47 E., it is 6 feet thick.

COAL QUALITY

Nineteen core samples were obtained on this project and were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value are shown for the Sonnette coal deposit in Table 71 and for the Threemile Buttes coal deposit in Table 73. Major ash constituents in the Sonnette coal deposit are shown in Table 72 and in the Threemile Buttes coal deposit in Table 74.

COAL RESERVES

The indicated reserves in the Pawnee coal bed are 320,250,000 tons, and inferred reserves are 183,060,000 tons, a total of 503,310,000 tons. The two benches of the Cook coal bed have indicated reserves of 362,980,000 tons, and total reserves in the Sonnette coal deposit are 866,290,000 tons (Table 70).

The Canyon coal bed and the Ferry coal bed in the Threemile Buttes deposit contain indicated reserves of 225,400,000 tons (Table 74).

Table 75.–Reserves, overburden, overburden ratio, acres, and tons/acre, Home Creek Butte coal deposit.

CANYON and FERRY BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	36.59	46.34	1.26	870.4	42,038.1
50 to 100	93.71	269.49	2.87	2,227.2	42,075.3
100 to 150	86.91	363.47	4.18	1,753.6	49,560.9
	Total 217.21	Total 679.30	Average 3.12	Total 4,851.2	Average 44,774.5

HOME CREEK BUTTE COAL DEPOSIT

LOCATION

The Home Creek Butte coal deposit (Pl. 26) is in T. 2 and 3 S., R. 47 E., and a very small portion of the deposit laps over into sec. 24 and 25, T. 2 S., R. 46 E., Powder River County. U.S. Highway 212 crosses the southern boundary of the mapped area. On the west, the area borders the Ashland coal deposit (Pl. 13), and on the south, it nearly adjoins the Threemile Buttes coal deposit (Pl. 24). To the east, the area nearly adjoins the Pumpkin Creek coal deposit (Pl. 15), and it is overlapped on the north by the Little Pumpkin Creek coal deposit (Pl. 27).

FIELD WORK AND MAP PREPARATION

The field work was completed in 1971 and included the drilling of two holes, SH-7153 and SH-7154, sec. 10, T. 3 S., R. 47 E. Data from an additional hole in sec. 33, T. 2 S., R. 47 E., were obtained from a private company. Clinker and burn lines were mapped in the winter of 1972 with the aid of colored aerial photos borrowed from the U.S. Forest Service.

PREVIOUS GEOLOGIC WORK

The Home Creek Butte coal deposit area was mapped by Bass (1932).

LAND OWNERSHIP

The Home Creek Butte coal deposit lies within the Custer National Forest. The Federal Government owns the surface and coal.

SURFACE FEATURES AND LAND USE

The Home Creek Butte coal deposit is on the high divide separating Little Pumpkin Creek from the East Fork of Otter Creek and Home Creek, both of which are tributaries of Otter Creek. Beaver Creek drains the northwestern part of the area.

The principal land use in the area is livestock grazing, but some land is cultivated by dry-land farming to produce wheat and other grain. Some timber is cut in the area and hauled to nearby Ashland for saw lumber.

GEOLOGIC STRUCTURE

Very little structural information is available in this area, but the information that is available indicates that the Ferry coal bed is nearly horizontal. The altitude of its top in sec. 33, T. 2 S., R. 47 E., is 21 feet lower than in drill hole SH-7154, sec. 10, T. 3 S., R. 47 E.

COAL BEDS

The Ferry coal bed is 24 feet thick, and in drill hole SH-7154, it is 76 feet below the Canyon bed, which is 10 feet thick. In T. 2 S., R. 47 E., only the Ferry coal bed contains strippable reserves. Although the Canyon coal bed may remain unburned in some places, it has only minimal reserves. The names Ferry and Canyon have been carried north from the Birney-Broadus area (Warren, 1959), where they are correlated with the coal beds in the Threemile Buttes coal deposit (Pl. 24) to the south.

COAL QUALITY

No analytical data were collected or available for coal in this coal deposit. It was assumed that the coal is similar to that in the Threemile Buttes coal deposit farther south.

COAL RESERVES

The indicated reserves in the Ferry and Canyon coal beds are 217,210,000 tons (Table 75).

Table 76.—Reserves, overburden, overburden ratio, acres, and tons/acre, Little Pumpkin Creek coal deposit.

SAWYER, A, C and D, X, and E BEDS

Thickness of overburden, ft.		Inferred reserves, million tons		Overburden and interburden, million cu. yd.		Overburden and interburden ratio, cubic yards/ton		Acres		Tons/acre
0 to 50		69.06		179.70		2.6		2,205.4		31,314.0
50 to 100		55.74		264.71		4.7		2,015.2		27,659.8
100 to 150		46.38		457.87		9.8		1,433.6		32,352.1
0 to 100		44.65		231.56		5.2		2,880.0		15,503.5
	Total	215.83	Total	1,133.84	Average	5.3	Total	8,534.2	Average	25,290.0

LITTLE PUMPKIN CREEK COAL DEPOSIT

LOCATION

The Little Pumpkin Creek coal deposit (Pl. 27) is in T. 1 and 2 S., R. 47 and 48 E., Powder River County. The deposit, confined to the sides and bottom of the valley of Little Pumpkin Creek, is overlapped on its north side by the Foster Creek coal deposit (Pl. 16A, B, and C). The area adjoins the Pumpkin Creek coal deposit (Pl. 15) to the east, the Beaver Creek-Liscom Creek coal deposit (Pl. 29) to the northwest, the Ashland coal deposit (Pl. 13A and B) to the west, and the Home Creek Butte coal deposit (Pl. 26) to the southwest.

FIELD WORK AND MAP PREPARATION

The field work in the Little Pumpkin Creek coal deposit was minimal and included only brief reconnaissance mapping on 7½-minute topographic quadrangle maps.

Color aerial photos lent by the U.S. Forest Service were utilized for drawing the coal outcrops and burn lines. Some private company drill holes shown on the map (Pl. 27) as L.P.C. drill holes, provided information on coal thickness, and the report by Bass (1932) provided additional figures on coal thickness.

PREVIOUS GEOLOGIC WORK

The Little Pumpkin Creek area was included in the report on the Ashland coal field (Bass, 1932).

LAND OWNERSHIP

The Little Pumpkin Creek area lies within the land grant to Burlington Northern, Inc., which has retained the coal rights, although it has conveyed the surface. The State of Montana owns the surface and minerals in sec. 16 and 36 in T. 1 S., R. 47 and 48 E., and some additional land in T. 1 S., R. 47 E. The Federal Government owns a large part of the surface and some coal rights in T. 2 S., R. 47 and 48 E., besides that part of the area included within Custer National Forest.

SURFACE FEATURES AND LAND USE

Little Pumpkin Creek has deeply incised a broad northward-trending valley, on both sides of which the terrain rises to steep-sided, high ridges. Clinker zones are numerous. Little Pumpkin Creek and its tributaries are intermittent streams, but Little Pumpkin Creek and some of the larger tributaries contain ponds of water all year.

The principal land uses in the area are livestock grazing, the raising of hay in valley meadows, and dry-land farming on summer fallowed fields. Dense forests on the west side of Little Pumpkin Creek support logging operations.

GEOLOGIC STRUCTURE

Very little information on the structure is available, but the strata seem to be almost horizontal.

COAL BEDS

The coal beds in the Little Pumpkin Creek area that contain strippable coal are, from top to bottom, the E, X, C and D, Sawyer, and A beds. The Knobloch bed may be counted also, because it contains strippable coal along Little Pumpkin Creek (Pl. 16A).

The E coal bed, about 7 feet thick (Bass, 1932), is 70 to 100 feet above the X bed. The X coal bed is about 8 feet thick and is about 40 to 80 feet above the C and D bed. Thickness of the clinker where the C and D coal beds have burned along Green Creek in the northern part of T. 2 S., R. 47 E., and along Stacey Creek in the southern part of T. 1 S., R. 47 E., indicates a coal thickness in excess of 10 feet.

The C and D coal beds are 80 to 100 feet above the Sawyer bed, which is 31 feet thick in drill hole PC-31, sec. 21, T. 2 S., R. 48 E. (Pl. 15). According to Carmichael (1967), the A bed splits from the Sawyer somewhere between PC-31 and sec. 32, T. 1 S., R. 48 E. The parting between the A bed and the Sawyer bed is prominent on both sides of Little Pumpkin Creek and averages about 40 feet in thickness. Farther south along Little Pumpkin Creek in the gamma log of an oil well in sec. 23, T. 2 S., R. 47 E., the Sawyer bed is 31 feet thick and seems to be combined with the A bed in this area. A coal bed 5 feet thick here lies 12 feet above the Sawyer bed.

The Sawyer and A coal beds thin on the west side of Little Pumpkin Creek in the center of T. 1 S., R. 47 E., and range in thickness from 6 to 9 feet.

COAL QUALITY

No core samples have been obtained from the Little Pumpkin Creek area, but the quality is believed to be similar to that in the Pumpkin Creek, Foster Creek, and the Beaver Creek-Liscom Creek areas.

COAL RESERVES

The coal reserves in the Little Pumpkin Creek area are classified as inferred because of the lack of drill holes in the area. The inferred reserves in the E coal bed, the X coal bed, the C and D coal bed, the Sawyer coal bed, and the A coal bed total 215,830,000 tons (Table 76).

Table 77.—Reserves, overburden, overburden ratio, acres, and tons/acre, Sand Creek coal deposit.

KNOBLOCH BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	98.54	138.26	1.4	2,665.1	36,974.2
50 to 100	130.58	306.35	2.3	2,553.1	51,145.6
100 to 150	38.22	148.05	3.9	734.0	52,070.8
	Total 267.34	Total 592.66	Average 2.22	Total 5,952.2	Average 44,914.4

SAND CREEK COAL DEPOSIT

LOCATION

The Sand Creek coal deposit (Pl. 28) is in portions of T. 1 N. and 1 S., R. 49 and 50 E., Custer and Powder River Counties. The area is about 50 miles south of Miles City on U.S. Highway 312, which traverses the southwest corner of the area. The Sand Creek coal deposit is a few miles north of the Broadus coal deposit (Pl. 17) and a few miles east of the Foster Creek coal deposit (Pl. 16A, B, and C).

FIELD WORK AND MAP PREPARATION

Field work in the Sand Creek coal deposit, completed in 1967 under a cooperative project between Burlington Northern, Inc., and the Montana Bureau of Mines and Geology, consisted of three drill holes and an altimeter survey conducted to gather topographic information for control in preparation of an overburden map. The field procedures followed those established by Burlington Northern (Carmichael, 1967). A structure-contour and overburden map was prepared by Loren A. Williams of Burlington Northern, Inc.

PREVIOUS GEOLOGIC WORK

The southern part of the Sand Creek coal field was mapped and described in the U.S. Geological Survey report on the Coalwood coal field (Bryson, 1952). The northern part of the area is included in U.S. Geological Survey report on the Mizpah coal field (Parker and Andrews, 1939). Brown and others (1954) and Ayler, Smith, and Deutman (1969) also describes the strippable coal.

LAND OWNERSHIP

The Sand Creek coal deposit lies within the boundaries of the land grant to Burlington Northern, Inc. Although the railroad has conveyed the surface, it has retained ownership of the coal in odd-numbered sections within the area. The State of Montana owns sec. 16 and 36 in each township including both surface and mineral rights; the rest of the surface is privately owned. Although individuals may own a small amount of coal, the Federal Government retained the coal rights on most of the even-numbered sections.

SURFACE FEATURES AND LAND USE

The Sand Creek coal deposit is in a mesa that has a rolling surface particularly well suited for strip mining. In the south end of the deposit, the sides of the mesa are very steep and dissected, but the top is flat or gently rolling.

Approximately three-quarters of the area is utilized for dry-land farming. The rest is used for livestock grazing. Thick clinker above the burned Knobloch coal bed retains adequate moisture to support stands of ponderosa pine trees along the sides of the mesa.

GEOLOGIC STRUCTURE

Although very little structural information is available, altitudes of the top of the Knobloch coal bed, as measured in drill holes, show that the strata dip to the north (Pl. 28).

COAL BEDS

The Knobloch coal bed, in the lower part of the Tongue River Member, contains the strippable coal reserves in the Sand Creek coal deposit. The Knobloch bed consists of two to four distinct benches. In drill hole SC-1, sec. 23, T. 1 N., R. 49 E., the Knobloch bed is in two benches; the upper bench is 17 feet thick, the lower is 15 feet, and the parting is only 3 feet. About 2 miles southwest, in drill hole SC-3, sec. 1, T. 1 S., R. 49 E., the Knobloch is split into four distinct benches. The upper Knob-

Table 78.–Proximate analysis, ultimate analysis, and heating value, Sand Creek coal deposit.

Drill hole and location	Depth sampled	USBM number	Coal bed	Form of analysis [1]	Proximate, %				Ultimate, %					Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	
SC-1C 1N 49E S23 CCDC	51 to 68 ft.	I-73091	Knobloch	A	31.10	27.81	32.81	8.28	.29	6.46	43.14	.63	41.20	7220
				B		40.37	47.61	12.02	.42	4.36	62.62	.92	19.66	10480
				C		45.89	54.11		.48	4.96	71.17	1.04	22.35	11910
	71 to 86 ft.	I-73092		A	32.57	28.30	34.06	5.07	.31	6.71	44.64	.65	42.62	7460
				B		41.97	50.52	7.51	.46	4.59	66.20	.96	20.28	11060
				C		45.38	54.62		.50	4.96	71.58	1.04	21.92	11960

[1] A, as received; B, moisture free; C, moisture and ash free.

Table 79.–Major ash constituents and fusibility of ash, Sand Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %											Fusibility of ash, °F		
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total	Initial deformation temp.	Softening temp.	Fluid temp.
SC-1C 1N 49E S23	51 to 68 ft.	GF-67-794	Knobloch	13.2	20.2	4.6	.63	6.6	1.9	.63	45.5	6.6	.84	100.7	2120	2160	2200
	71 to 86 ft.	GF-67-795		12.5	33.0	6.4	.64	7.7	.50	1.04	20.0	12.4	.45	94.6	2460	2500	2540

loch bench seems to have split into three benches, 7 feet, 8 feet, and 8 feet thick; the lower or fourth bench is 14 feet thick. In drill hole SC-2, in sec. 9, T. 1 S., R. 50 E., the Knobloch bed again is in two benches; the upper bench is 7 feet thick and the lower bench is 10 feet. The thickness of the parting between the upper and lower benches of the Knobloch coal bed increases markedly from north to south across the coal deposit. At the northern end, the two benches are separated by a 3-foot parting in drill hole SC-1C, but in drill hole SC-2, thickness of the parting has increased to 43 feet.

COAL QUALITY

Both benches of the Knobloch coal bed were cored in drill hole SC-1C, sec. 23, T. 1 N., R. 49 E., during the 1967 cooperative field program. The cores were analyzed by the U.S. Bureau of Mines, Grand Forks Coal Research Laboratory. Proximate analysis, ultimate analysis, and heating value are shown in Table 78; major ash constituents and fusibility of ash are shown in Table 79.

COAL RESERVES

Reserves in the Knobloch coal bed total 267,340,000 tons (Table 77).

BEAVER CREEK-LISCOM CREEK COAL DEPOSIT

LOCATION

The Beaver Creek-Liscom Creek coal deposit is in T. 1 N. and 1 S., R. 45 and 46 E. (Pl. 29), Powder River and Rosebud Counties. The northern and western boundaries of the coal deposit are the lowlands along the valley of the Tongue River where erosion has removed the coal beds, and the southern boundary is the high area of the Cook Mountains where overburden is too great for potential strip mining of the coal. To the east, the area borders the Foster Creek coal deposit (Pl. 16A, B, and C), and to the southeast it borders the Little Pumpkin Creek coal deposit (Pl. 27). To the south, the area borders the Ashland coal deposit (Pl. 13A and B).

FIELD WORK AND MAP PREPARATION

The field work in the Beaver Creek-Liscom Creek area, completed in the summer of 1970, included drilling numerous exploration holes and mapping the surface on topographic quadrangle maps and on black-and-white aerial photos. Color photos, borrowed from the U.S. Forest Service, were used in mapping the south half of T. 1 N., R. 46 E., and T. 1 S., R. 45 and 46 E.

PREVIOUS GEOLOGIC WORK

The Beaver Creek-Liscom Creek area was included in the report on the Ashland coal field (Bass, 1932). The eastern corner of the mapped area overlaps the Foster Creek coal deposit (Pl. 16A, B, and C), which was discussed in Montana Bureau of Mines and Geology Bulletin 73 (Gilmour and Williams, 1969), and two drill holes included in the Foster Creek report are shown on Plate 29.

SURFACE FEATURES AND LAND USE

The most prominent surface features in the mapped area are the wide northwest-trending valleys of Liscom Creek and Beaver Creek, both tributaries of the Tongue River. The area is characterized by gently rolling grassland and long steep-sided clinker-capped ridges. The divide between Liscom Creek and Beaver Creek is a dissected ridge bordered by steep slopes and cliffs of thick resistant clinker formed by the burning of the Knobloch coal bed.

The principal land use in the area is livestock grazing, supplemented by dry-land farming. The principal crops are hay and grains.

LAND OWNERSHIP

The Beaver Creek-Liscom Creek coal deposit lies within the land grant to Burlington Northern, Inc., and the coal on the odd-numbered sections has been retained by the railroad, although the surface has been conveyed. The State of Montana owns the surface and the minerals in sec. 16 and 36 of each township and some additional land in T. 1 S., R. 45 and 46 E. The Federal Government owns the coal in most of the rest of the area and has a fairly large amount of the surface in T. 1 N., R. 45 E., and a few isolated tracts in T. 1 N., R. 46 E., besides the part of T. 1 S., R. 46 E., that is within the Custer National Forest.

GEOLOGIC STRUCTURE

The strata in the Beaver Creek area are almost horizontal but dip slightly to the west. The Knobloch coal bed is structurally highest in drill hole SH-7083, in sec. 2, T. 1 S., R. 46 E. This structural high seems to coincide with the divide between Beaver Creek and Liscom Creek. A northeast-trending fault in the vicinity of drill hole SH-7078, sec. 36, T. 1 S., R. 45 E., has downdropped the strata on the southeast side about 40 feet.

COAL BEDS

The coal beds that have economic value in the Beaver Creek-Liscom Creek coal deposit are, from top to bottom, the Knobloch, Flowers-Goodale, and Terret beds. The

Table 80.—Reserves, overburden, overburden ratio, acres, and tons/acre, Beaver Creek-Liscom Creek coal deposit.

TERRET, FLOWERS–GOODALE, and KNOBLOCH BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	175.80	490.10	2.78	8,236.8	21,343.2
50 to 100	294.89	1,559.98	5.29	12,441.6	23,701.1
100 to 150	156.80	1,069.82	6.82	5,248.0	29,878.0
	Total 627.49	Total 3,119.90	Average 4.97	Total 25,926.4	Average 24,203.1

KNOBLOCH BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden and interburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	121.70	292.13	2.40	4,518.4	26,934.3
50 to 100	213.12	938.91	4.40	7,308.8	29,159.4
100 to 150	156.8	1,069.82	6.82	5,248.0	29,878.0
	Total 491.62	Total 2,300.86	Average 4.68	Total 17,075.2	Average 28,791.8

TERRET BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	10.26	51.45	5.01	966.4	10,616.7

FLOWERS–GOODALE BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	43.84	146.52	3.34	2,752.0	15,930.2
50 to 100	81.77	621.07	7.59	5,132.8	15,930.9
	Total 125.61	Total 767.59	Average 6.11	Total 7,884.8	Average 15,930.7

Knobloch coal bed contains the largest amount of strippable reserves in the area and has a maximum measured thickness of 22 feet in drill hole SH-7075, sec. 32, T. 1 S., R. 45 E. It thins and splits northeastward and has a thickness of 14 feet in two benches in drill hole SH-7091, sec. 16, T. 1 N., R. 46 E. The lower bench of the Knobloch has previously been mapped as the Lay Creek coal bed in parts of the area, but drill hole SH-7075, sec. 32, T. 1 S., R. 45 E., indicates that the Lay Creek bed is a split from the Knobloch bed. Throughout T. 1 S., R. 45 and 46 E., the "Lay Creek" coal bed maintains a thickness of 5 to 6 feet, except in drill hole SH-7083, where it is only 4 feet thick. The Flowers-Goodale bed is thickest in the northeast part of the area. In drill hole SH-7083, in sec. 2, T. 1 S., R. 46 E., it is 12 feet thick; in drill hole SH-7076, in sec. 14, T. 1 S., R. 45 E., it is 9 feet thick. The Terret coal bed is 10 feet thick in drill hole SH-7083 and 6 feet thick in drill hole SH-7076.

The thick stratigraphic section penetrated in drill hole SH-7083 shows the relationship of the coal beds. In this drill hole, the section between the Knobloch and "Lay Creek" beds is at its maximum of 88 feet, from top to top. The section between the Flowers-Goodale and Terret beds is 43 feet, about the same as in drill hole SH-7076. In SH-7083, the section between the Knobloch and Flowers-Goodale beds is 188 feet, and it decreases westward to about 100 feet in sec. 36, T. 1 N., R. 45 E.

Table 81.—Proximate analysis, forms of sulfur, and heating value, Beaver Creek-Liscom Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7074 1S 45E S20 BAAD	100 to 106 ft.	307	Knobloch	A	27.530	28.517	36.800	7.154	.496	.016	.366	.114	8417
				B		39.349	50.780	9.871	.684	.022	.505	.157	11614
				C		43.659	56.341		.759	.025	.560	.174	12886
	106 to 116 ft.	308		A	28.010	28.170	34.484	9.336	.512	.008	.179	.325	8052
				B		39.131	47.901	12.968	.711	.011	.248	.451	11185
				C		44.962	55.038		.817	.013	.285	.519	12852
	116 to 120 ft.	309		A	29.160	25.519	38.013	7.308	.241	.008	.092	.141	8237
				B		36.024	53.660	10.316	.341	.012	.129	.200	11627
				C		40.168	59.832		.380	.013	.144	.223	12965
SH-7076 1S 45E S14 DDBD	53 to 62 ft.	311	Flowers-Goodale	A	27.770	28.100	35.986	8.144	.961	.016	.759	.186	8102
				B		38.904	49.821	11.275	1.331	.022	1.051	.257	11217
				C		43.848	56.152		1.500	.025	1.185	.290	12642
SH-7077 1S 45E S34 ABBB	92 to 100 ft.	312	Knobloch	A	28.910	28.094	36.933	6.063	.600	.032	.456	.112	8383
				B		39.518	51.952	8.529	.844	.045	.641	.158	11793
				C		43.203	56.797		.923	.049	.701	.172	12892
	100 to 109 ft.	313		A	30.220	27.678	37.031	5.071	.413	.008	.195	.211	8401
				B		39.665	53.069	7.267	.593	.011	.279	.302	12039
				C		42.773	57.227		.639	.012	.301	.325	12983
SH-7079 1S 46E S28 BBCC	42 to 52 ft.	314	Knobloch	A	30.530	26.697	36.380	6.394	.472	.008	.325	.139	7871
				B		38.429	52.368	9.203	.680	.011	.468	.201	11330
				C		42.324	57.676		.749	.012	.515	.221	12479
SH-7080 1S 46E S34 CACB	85 to 95 ft.	315	Knobloch	A	29.740	27.247	35.512	7.501	.279	.016	.104	.159	7933
				B		38.781	50.544	10.675	.397	.023	.147	.227	11291
				C		43.415	56.585		.444	.025	.165	.254	12640
	95 to 100 ft.	316		A	31.080	37.536	25.563	5.821	.199	.017	.017	.166	7925
				B		54.463	37.091	8.446	.289	.024	.024	.241	11499
				C		59.488	40.512		.315	.026	.026	.263	12560
SH-7083 1S 46E S2 CCCD	103 to 105 ft.	318	Knobloch	A	26.140	29.876	32.427	11.557	.856	.026	.548	.282	7918
				B		40.450	43.904	15.647	1.159	.035	.742	.382	10721
				C		47.953	52.047		1.374	.041	.879	.453	12710
SH-7084 1N 45E S36 BABD	54 to 61 ft.	319	Flowers-Goodale	A	29.000	28.591	36.850	5.560	.380	.110	.127	.143	8271
				B		40.269	51.901	7.830	.535	.154	.178	.202	11649
				C		43.690	56.310		.580	.168	.193	.219	12639
SH-7092 1N 46E S18 ADDD	67 to 77 ft.	320	Knobloch	A	27.570	26.598	32.016	13.816	.813	.017	.516	.279	7362
				B		36.723	44.203	19.074	1.122	.023	.713	.386	10164
				C		45.378	54.622		1.386	.029	.881	.477	12559
	93 to 101 ft.	322		A	29.760	27.421	34.571	8.249	.768	.016	.509	.242	7771
				B		39.038	49.218	11.744	1.093	.023	.725	.345	11063
				C		44.233	55.767		1.238	.026	.821	.391	12535
SH-7093 1N 46E S30 ABCC	52 to 60 ft.	323	Knobloch	A	29.580	28.435	34.659	7.276	.263	.000	.008	.254	7908
				B		40.450	49.217	10.332	.373	.000	.012	.361	11230
				C		45.111	54.889		.416	.000	.013	.403	12524
SH-7094 1N 45E S16 BBDA	38 to 44 ft.	324	Terret	A	28.990	26.921	38.322	5.767	.691	.025	.499	.166	8170
				B		37.912	53.967	8.121	.973	.035	.703	.234	11506
				C		41.263	58.737		1.059	.038	.765	.255	12523

1/A, as received; B, moisture free; C, moisture and ash free.

Table 82.–Major ash constituents, Beaver Creek-Liscom Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7074 1S 45E S20 BAAD	100 to 120 ft.	307-309	Knobloch	15.9	16.5	3.8	.7	5.4	.8	.2	44.6	9.3	.7	97.9
SH-7076 1S 45E S14 DDBD	53 to 62 ft.	311	Flowers-Goodale	15.3	13.2	14.7	.5	4.4	.2	.4	30.2	17.7	.5	97.1
SH-7077 1S 45E S34 ABBB	92 to 109 ft.	312-313	Knobloch	17.2	23.0	5.6	.2	8.3	3.1	.3	24.3	15.1	.4	97.5
SH-7079 1S 46E S28 BBCC	42 to 52 ft.	314	Knobloch	13.8	21.6	8.7	.1	6.7	.4	2	31.2	15.3	.6	98.6
SH-7080 1S 46E S34 CACB	85 to 100 ft.	315-316	Knobloch	12.9	17.4	4.7	.2	6.3	1.2	.2	46.0	7.8	.9	97.6
SH-7083 1S 46E S2 CCCD	103 to 105 ft.	318	Knobloch	7.9	14.8	7.5	.1	3.6	.7	.2	49.7	12.1	1.0	97.6
SH-7084 1N 45E S36 BABD	54 to 61 ft.	319	Flowers-Goodale	16.9	11.4	6.0	.8	3.8	.5	.1	50.7	7.6	.7	98.5
SH-7092 1N 46E S18 ADDD	93 to 101 ft.	322	Knobloch	15.2	16.8	12.8	.3	3.5	1.2	.1	28.4	18.0	.6	96.9
SH-7093 1N 46E S30 ABCC	52 to 60 ft.	323	Knobloch	13.6	20.5	6.4	.1	3.7	3.6	1.4	40.9	7.4	1.2	98.8
SH-7094 1N 45E S16 BBDA	38 to 44 ft.	324	Terret	9.5	19.9	12.2	.1	7.4	1.0	.2	19.8	21.6	.2	91.9

COAL QUALITY

The fifteen core samples obtained were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value are shown in Table 81, and major ash constituents are shown in Table 82.

COAL RESERVES

Strippable reserves in the Beaver Creek-Liscom Creek coal deposit total 627,490,000 tons, of which the Knobloch bed accounts for 491,620,000 tons (Table 80).

GREENLEAF CREEK-MILLER CREEK COAL DEPOSIT

LOCATION

The Greenleaf Creek-Miller Creek coal deposit (Pl. 30) in parts of T. 1 and 2 S., R. 42 and 43 E., Rosebud County, is bounded on the south by the Northern Cheyenne Indian Reservation north boundary, on the east by the Tongue River valley, and on the west by the valley of Rosebud Creek.

FIELD WORK AND MAP PREPARATION

The field work in the Greenleaf Creek-Miller Creek area during the summer of 1970 was followed in the summer of 1972 by geologic mapping on black-and-white aerial photos and 7½-minute topographic quadrangle maps. Overburden maps were prepared during the following winter.

PREVIOUS GEOLOGIC WORK

The area has been mapped by the U.S. Geological Survey (Bass, 1932). Strippable coal was described in later reports by Kepferle (1954) and Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

The Greenleaf Creek-Miller Creek area lies within the land grant to Burlington Northern, Inc., whereby the railroad was granted available odd-numbered sections along its right-of-way. Although the railroad has retained ownership of the mineral rights, it has conveyed most of the surface. The State of Montana owns sec. 16 and 36 in each township and has retained its surface and mineral rights. In the rest of the area, most of the surface is privately owned, but most of the coal is owned by the Federal Government.

SURFACE FEATURES AND LAND USE

Much of the coal deposit underlies an asymmetric ridge forming the divide between the northeastward-flowing Greenleaf Creek on the east and the northward-flowing Miller Creek on the west. Both of these intermittent streams are tributaries of Rosebud Creek. A few knobs on the crest of the ridge are capped by the clinker that resulted from burning of the Sawyer coal bed. The western side of the ridge rises abruptly from the coal outcrop to the crest, but the eastern side is broad and rolling. Farther east, the topography becomes more rugged as the clinker of the burned Knobloch bed is encountered; valleys become narrow and steep sided. Farther south, the clinker of the Sawyer bed forms a sharp ridgeline.

The principal land use in the area is livestock grazing supplemented by some dry-land farming and raising of hay in meadows along the valley bottoms of Greenleaf Creek and Miller Creek. The clinkered areas are covered with stands of ponderosa pine.

GEOLOGIC STRUCTURE

The strata in the Greenleaf Creek-Miller Creek coal deposit are almost horizontal, but show an apparent dip to

Table 83.—Reserves, overburden, overburden ratio, acres, and tons/acre, Greenleaf Creek-Miller Creek coal deposit.

ROSEBUD, KNOBLOCH, and SAWYER BEDS

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	135.8	240.56	1.77	4,480.0	30,312.5
50 to 100	196.01	823.97	4.20	6,790.4	28,865.7
100 to 150	121.90	740.70	6.07	3,648.0	33,415.6
	Total 453.71	Total 1,805.22	Average 3.97	Total 14,918.4	Average 30,413.5

Table 84.–Proximate analysis, forms of sulfur, and heating value, Greenleaf Creek-Miller Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7096 1S 43E S28 DBBA	59 to 67 ft.	325	Knobloch	A	27.930	28.271	37.043	6.755	.422	.017	.181	.224	8510
				B		39.228	51.399	9.374	.586	.024	.251	.311	11808
				C		43.285	56.715		.646	.026	.277	.343	13029
	67 to 74 ft.	326		A	27.180	28.201	38.539	6.080	.359	.017	.111	.231	8692
				B		38.727	52.924	8.349	.493	.023	.153	.317	11936
				C		42.255	57.745		.538	.026	.167	.346	13024
	74 to 83 ft.	327		A	28.050	26.677	37.877	7.396	.617	.042	.313	.262	8247
				B		37.077	52.643	10.280	.858	.059	.435	.364	11461
				C		41.325	58.675		.956	.065	.484	.406	12775
SH-7097 1S 43E S34 CBCB	43 to 45 ft.	328	Local	A	28.610	25.223	25.554	20.613	1.890	.031	1.006	.853	6554
				B		35.331	35.794	28.874	2.647	.043	1.410	1.195	9181
				C		49.675	50.325		3.722	.061	1.982	1.680	12908
	77 to 86 ft.	329	Sawyer	A	29.060	27.315	38.961	4.665	.317	.000	.106	.211	8423
				B		38.504	54.920	6.576	.447	.000	.149	.298	11873
				C		41.214	58.786		.478	.000	.159	.319	12709
SH-7098 1S 43E S32 BDCC	58 to 68 ft.	373	Sawyer	A	24.100	31.631	36.786	7.483	.541	[illegible]	.060	.455	8815
				B		41.675	48.466	9.859	.713	.034	.079	.600	11614
				C		46.233	53.767		.791	.038	.088	.665	12884
	68 to 78 ft.	374		A	28.160	27.706	39.615	4.519	.218	.032	.024	.162	8436
				B		38.566	55.143	6.291	.304	.045	.034	.225	11743
				C		41.155	58.845		.324	.048	.036	.240	12532
SH-7099 2S 43E S6 BDDA	125 to 133 ft.	330	Sawyer	A	26.150	29.960	38.001	5.889	.214	.017	.009	.189	8805
				B		40.569	51.457	7.974	.290	.023	.012	.255	11922
				C		44.084	55.916		.315	.025	.013	.277	12955
SH-70100 1S 42E S36 ACBB	92 to 100 ft.	331	Knobloch	A	26.330	29.504	38.627	5.538	.439	.000	.166	.273	8935
				B		40.049	52.433	7.518	.596	.000	.225	.371	12128
				C		43.305	56.695		.644	.000	.243	.401	13114
	100 to 102 ft.	332		A	23.610	31.894	38.451	6.045	.388	.000	.066	.322	9238
				B		41.751	50.335	7.914	.508	.000	.086	.422	12093
				C		45.339	54.661		.552	.000	.094	.458	13132
SH-70101 1S 42E S24 BCCA	43 to 50 ft.	333	Rosebud	A	27.080	27.115	39.058	6.747	.696	.000	.593	.103	8590
				B		37.184	53.563	9.253	.955	.000	.814	.141	11780
				C		40.975	59.025		1.052	.000	.896	.155	12981
	50 to 55 ft.	334		A	26.300	26.189	35.187	12.324	2.393	.016	2.101	.276	8175
				B		35.535	47.743	16.722	3.247	.022	2.851	.374	11092
				C		42.670	57.330		3.900	.026	3.424	.449	13319
SH-70102 1S 43E S16 BADA	41 to 51 ft.	335	Knobloch	A	28.060	27.392	37.981	6.567	.438	.000	.223	.215	8209
				B		38.076	52.795	9.129	.609	.000	.310	.299	11411
				C		41.901	58.099		.671	.000	.341	.329	12557
	51 to 59 ft.	336		A	28.670	28.165	36.854	6.310	.406	.000	.242	.164	8432
				B		39.486	51.668	8.846	.569	.000	.339	.230	11821
				C		43.318	56.682		.624	.000	.372	.252	12968
	59 to 61 ft.	337		A	29.410	27.883	36.006	6.701	1.253	.023	1.169	.061	8377
				B		39.500	51.007	9.493	1.775	.032	1.656	.087	11867
				C		43.643	56.357		1.961	.036	1.830	.096	13112
	210 to 216 ft.	338	Rosebud	A	27.830	27.453	37.962	6.756	.696	.023	.477	.195	8454
				B		38.039	52.600	9.361	.964	.033	.661	.271	11714
				C		41.967	58.033		1.064	.036	.729	.299	12924
	216 to 226 ft.	339		A	27.490	26.213	37.756	8.541	.892	.024	.716	.151	8286
				B		36.151	52.069	11.780	1.230	.033	.988	.209	11427
				C		40.978	59.022		1.394	.037	1.120	.236	12953

[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 85.–Major ash constituents, Greenleaf Creek-Miller Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7096 1S 43E S28 DBBA	59 to 83 ft.	325-327	Knobloch	17.9	17.0	4.5	.7	4.8	.4	.4	38.8	9.4	.9	94.8
SH-7097 1S 43E S34 CBCB	43 to 45 ft.	328	Local	20.9	3.6	9.3	2.5	1.5	.1	.2	53.1	3.1	.7	95.0
	77 to 86 ft.	329	Sawyer	18.1	14.9	7.2	.3	3.9	11.7	.4	28.2	11.5	.6	96.8
SH-7098 1S 43E S32 BDCC	58 to 78 ft.	373-374	Sawyer	18.4	14.3	4.9	.4	3.3	9.2	.5	35.0	9.5	.7	96.2
SH-7099 2S 43E S6 BDDA	125 to 133 ft.	330	Sawyer	15.4	14.1	4.5	.2	2.8	9.0	.4	41.8	8.0	.9	97.1
SH-70100 1S 42E S36 ACBB	92 to 102 ft.	331-332	Knobloch	18.0	15.7	6.2	.2	5.0	4.2	.4	31.1	13.4	.7	94.9
SH-70101 1S 42E S24 BCCA	43 to 55 ft.	333-334	Rosebud	15.6	10.5	14.5	1.2	3.7	.6	.5	38.4	10.9	.7	96.6
SH-70102 1S 43E S16 BADA	41 to 61 ft.	335-337	Knobloch	16.5	17.1	5.9	.1	5.1	.2	.3	35.5	13.0	.7	94.4
	210 to 226 ft.	338-339	Rosebud	16.0	11.0	17.8	1.0	3.4	.7	.5	35.6	10.1	.5	96.6

the south. The top of the Knobloch coal bed is highest in the northern part of the deposit, 3,258 feet in drill hole SH-70102, in sec. 16, T. 1 S., R. 43 E., and it declines to 3,218 feet in drill hole SH-7096 in sec. 28 and to 3,169 feet in drill hole SH-7098 in sec. 32.

Two small faults have been mapped in sec. 32 and 33, T. 1 S., R. 43 E. (Bass, 1932). The southernmost fault, in the southwest quarter of sec. 33, is downthrown on the south about 75 feet; the fault surface dips steeply northward. The second fault, in the northern part of sec. 32, is downthrown on the north about 50 feet or less (Bass, 1932, p. 45).

COAL BEDS

Coal beds in the Greenleaf Creek-Miller Creek coal deposit that have economic value are, from bottom to top, the Rosebud, Knobloch, and Sawyer beds. The stratigraphic distance between the Rosebud and the Knobloch increases, west to east, from 89 feet in drill hole SH-70100, sec. 36, T. 1 S., R. 42 E., to 151 feet in drill hole SH-70102, sec. 16, T. 1 S., R. 43 E. A similar separation is indicated by drill hole SH-7096, sec. 28, T. 1 S., R. 43 E., but the gamma log of an oil well in sec. 34, T. 1 S., R. 43 E., shows a further increase to 166 feet of strata between the two coal beds. The Sawyer bed is 178 feet above the Knobloch bed in drill hole SH-7098, sec. 32, T. 1 S., R. 43 E.

The Knobloch coal bed is 23 feet thick in drill hole SH-7096 in T. 1 S., R. 43 E., but thins westward to about 17 feet in drill hole SH-70100 in T. 1 S., R. 42 E. The Rosebud coal bed is 13 to 14 feet thick in T. 1 S., R. 42 E., but thins eastward to 9 feet as shown by the gamma log of an oil well in sec. 34, T. 1 S., R. 43 E. The Sawyer coal bed is 19 feet thick in drill holes SH-7098 and SH-7099. In drill hole SH-7097, sec. 34, T. 1 S., R. 43 E., it is only 10 feet thick.

COAL QUALITY

Seventeen project core samples were obtained and were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating value are shown in Table 84, and major ash constituents are shown in Table 85.

COAL RESERVES

Strippable reserves in the Rosebud, Knobloch, and Sawyer coal beds total 453,710,000 tons (Table 83).

PINE HILLS COAL DEPOSIT

LOCATION

The Pine Hills coal deposit (Pl. 31), in T. 7 N., R. 49 and 50 E., Custer County, is 14 miles east of Miles City; U.S. Highway 12 traverses the northwest corner of the mapped area. Coal has been mined by underground methods at the now abandoned Storm King mine in sec. 4, T. 7 N., R. 49 E., but fires in 1969 and 1970 totally destroyed the old workings and caused the surface to collapse.

FIELD METHODS AND MAP PREPARATION

The field work for the Pine Hills coal deposit, a cooperative project of Burlington Northern, Inc., and the Montana Bureau of Mines and Geology, was completed in 1968. Loren Williams was in charge of the field mapping and was assisted by Peter Mattson of Burlington Northern and by Gardar Dahl and Robert Lambeth of the Montana Bureau of Mines and Geology. The field method utilized was developed by Burlington Northern, Inc., (Carmichael, 1967). The field work included setting temporary bench marks throughout the area and obtaining topographic control by careful altimeter surveys. Details on the quality and quantity of coal were obtained by drilling and collecting core samples.

PREVIOUS GEOLOGIC WORK

The geology of the area was described in a U.S. Geological Survey report on the Miles City coal field (Collier and Smith, 1909). Strippable coal in the Pine Hills coal deposit was described by Brown and others (1954) and by Ayler, Smith, and Deutman (1969).

LAND OWNERSHIP

Burlington Northern, Inc., owns part of the odd-numbered sections in the two townships containing the Pine Hills coal deposit. The railroad has kept the coal although it has conveyed most of the surface. The State of Montana owns the surface and the coal in sec. 16 and 36, T. 7 N., R. 49 E., and sec. 16, T. 7 N., R. 50 E. Although the Federal Government has conveyed the surface, it has retained the coal rights in the rest of the area.

SURFACE FEATURES AND LAND USE

The Pine Hills coal deposit underlies a high ridge that forms the divide between Cottonwood Creek, an intermittent stream that flows northward to the Yellowstone River, and Mill Creek, an intermittent stream that flows

Table 86.—Reserves, overburden, overburden ratio, acres, and tons/acre, Pine Hills coal deposit.

DOMINY BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	68.45	110.73	1.61	2,080	32,908.7
50 to 100	95.07	357.77	3.76	2,956.8	32,153.0
100 to 150	30.35	198.72	6.54	985.6	30,793.4
	Total 193.87	Total 667.72	Average 3.44	Total 6,022.4	Average 32,191.5

Thickness of overburden, ft.	Inferred reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 150	86.09	367.84	4.27	3,040	28,319.1

Thickness of overburden, ft.	Indicated and inferred reserves, million tons	Overburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 150	279.96	1,035.06	3.69	9,062.4	30,892.5

southwestward to the Tongue River. Farther south the divide separates the Tongue River drainage from the Powder River drainage to the east. The top of the divide is smooth and rolling, but the edges are steep and rugged and reveal resistant clinker produced by burning of the Dominy coal bed. Ponderosa pine trees line the fringes of the divide.

The principal land uses are livestock grazing and dryland farming.

GEOLOGIC STRUCTURE

The strata in the Pine Hills coal deposit are almost horizontal. The maximum difference in the altitude of the top of the Dominy coal bed in the three drill holes is only 22 feet.

COAL BEDS

Strippable reserves in the Pine Hills coal deposit are confined to the Dominy coal bed, which consists of two benches. The thickness of the lower bench ranges from 16 to 24 feet (Brown and others, 1954), but in the three project drill holes, it ranges from 17 to 20 feet (Pl. 31). The upper bench of the Dominy is 3 to 4 feet thick, as shown in the drill holes, and is 5 to 6 feet above the thick lower bench.

The F coal bed, above the Dominy bed, has burned throughout the area except for a small patch described by Collier and Smith (1907, p. 57). Its clinker caps the buttes and ridges in the area.

COAL QUALITY

Three core samples were obtained during the field evaluation of the Pine Hills coal deposit, and they were analyzed by the U.S. Bureau of Mines, Grand Forks Coal Research Laboratory. Proximate analysis, ultimate analysis, heating value, and forms of sulfur are shown in Table 87. Major ash constituents and fusibility of ash are shown in Table 88.

COAL RESERVES

The indicated reserves in the Pine Hills coal deposit in the main bench of the Dominy coal bed are 193,870,000 tons. Inferred reserves in the eastern part of the area amount to an additional 86,090,000 tons (Table 86).

Table 87.--Proximate analysis, ultimate analysis, heating value, and forms of sulfur, Pine Hills coal deposit.

Drill hole and location	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Ultimate, %					Heating value (Btu)	Form of sulfur, %		
				Moisture	Volatile matter	Fixed carbon	Ash	S	H	C	N	O		Sulfate	Pyritic	Organic
PH-1C 7N 50E S29 ACAB	GF-68- 1865	Dominy	A	32.01	27.77	33.24	6.98	.56	6.43	43.95	.65	41.43	7240	.05	.32	.18
			B		40.84	48.89	10.27	.82	4.22	64.63	.96	19.10	10650	.07	.48	.27
			C		45.52	54.48		.91	4.70	72.03	1.07	21.29	11870	.08	.53	.30
PH- 2C 7N 49E S13 DCDA	GF-68- 1862	Dominy	A	30.85	27.32	33.68	8.15	.62	6.22	43.89	.70	40.42	7220	.05	.39	.19
			B		39.51	48.70	11.79	.90	4.04	63.47	1.02	18.78	10440	.07	.56	.27
			C		44.79	55.21		1.02	4.58	71.95	1.15	21.30	11840	.08	.64	.31
PH-3C 7N 49E S11 CDDD	GF-68- 1863	Dominy	A	30.66	28.17	34.61	6.56	.43	6.33	45.19	.71	40.78	7420	.02	.06	.34
			B		40.63	49.91	9.46	.62	4.22	65.17	1.02	19.51	10710	.03	.09	.49
			C		44.87	55.13		.68	4.66	71.97	1.13	21.56	11820	.04	.10	.54

1/A, as received; B, moisture free; C, moisture and ash free.

Table 88.--Major ash constituents and fusibility of ash, Pine Hills coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %												Fusibility of ash, °F		
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	LOI @ 800. °C	Total	Initial deformation temp.	Softening temp.	Fluid temp.
PH-1C 7N 50E S29 ACAB	95 to 112 ft.	GF-68- 1865	Dominy	12.0	27.4	8.3	.1	8.7	.5	.4	23.7	15.2	.5	.1	96.9	2250	2300	2350
PH-2C 7N 49E S13 DCDA	143 to 161 ft.	GF-68- 1862	Dominy	12.2	26.0	8.3	.7	6.7	2.4	.3	25.5	15.4	.4	.1	98.0	2250	2300	2350
PH-3C 7N 49E S11 CDDD	74 to 93 ft.	GF-68- 1863	Dominy	11.2	34.4	5.6	.2	9.7	1.3	.2	20.1	13.9	.4	.2	97.2	2420	2470	2520

Table 89.—Reserves, overburden, overburden ratio, acres, and tons/acre, Knowlton coal deposit.

DOMINY BED

Thickness of overburden, ft.		Indicated reserves, million tons		Overburden and interburden, million cu. yd.		Overburden and interburden ratio, cubic yards/ton		Acres		Tons/acre
0 to 50		219.61		462.35		2.10		3,471.45		63,260.8
50 to 100		425.86		1,723.99		4.04		12,918.49		32,965.1
100 to 150		102.04		513.15		5.02		3,223.28		31,656.9
	Total	747.51	Total	2,699.49	Average	3.61	Total	19,613.32	Average	38,112.3

Thickness of overburden, ft.		Indicated reserves, million tons		Overburden, million cu. yd.		Overburden ratio, cubic yards/ton		Acres		Tons/acre
0 to 50		58.34		65.00		1.11		3,180.8		18,341.3
50 to 100		37.64		93.56		2.48		768.0		49,010.4
100 to 150		24.33		101.06		4.15		499.2		48,737.9
	Total	120.31	Total	259.62	Average	2.15	Total	4,448.0	Average	27,048.1

KNOWLTON COAL DEPOSIT

LOCATION

The Knowlton coal deposit (Pl. 32A and B) is in T. 6 and 7 N., R. 53 and 54 E., Custer County, about 40 miles east of Miles City. U.S. Highway 12 crosses the north end of the mapped area. The coal field underlies the high divide between the Powder River valley to the west and the O'Fallon Creek valley to the east.

FIELD WORK AND MAP PREPARATION

All the field work resulting in the present map of the Knowlton coal deposit was completed during the summer of 1971. Geologic mapping on 7½-minute topographic maps, where available, was supplemented by mapping on black-and-white aerial photos for the rest of the area.

PREVIOUS GEOLOGIC WORK

The Knowlton coal deposit was originally mapped by the U.S. Geological Survey. The western part of the area was described in the Miles City coal report (Collier and Smith, 1909). The eastern part was included in the report on the Baker lignite field (Bowen, 1912).

LAND OWNERSHIP

The Knowlton coal deposit lies within the land grant to Burlington Northern, Inc. The railroad, although it has conveyed much of the surface, has retained the coal rights. At the time of the grant, some odd-numbered sections were not available, so the railroad's coal ownership in the area is not complete. The State of Montana owns surface and minerals on sec. 16 and 36 in each township. The Federal Government has conveyed most of the surface, but has, in general, retained the mineral rights, although some coal is privately owned.

SURFACE FEATURES AND LAND USE

The Knowlton coal deposit underlies the high divide between Powder River to the west and O'Fallon Creek to the east. The divide is a relatively flat, gently rolling plateau bordered by clinker, which supports ponderosa pine. All of the streams in the area are intermittent and flow only during periods of heavy precipitation or spring runoff. Numerous springs in the area supply abundant water for livestock.

The principal land uses in the area are livestock grazing and dry-land farming for which the gently rolling terrain is ideally suited. Various grains are cultivated, and hay is raised in many fields.

GEOLOGIC STRUCTURE

The strata in the Knowlton coal deposit are almost horizontal, but a northwest dip of a few feet per mile can be detected.

Table 90.–Proximate analysis, forms of sulfur, and heating value, Knowlton coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7158 7N 54E S16 BBBB	22 to 32 ft.	412	Dominy (L)	A	36.400	25.873	29.550	8.178	.684	.153	.473	.058	6323
				B		40.680	46.462	12.859	1.076	.240	.744	.092	9942
				C		46.682	53.318		1.235	.276	.854	.105	11408
SH-7159 7N 54E S21 DADB	51 to 60 ft.	413	Dominy (U)	A	38.110	25.224	30.683	5.983	.567	.029	.481	.057	6654
				B		40.757	49.576	9.667	.917	.046	.778	.093	10752
				C		45.118	54.882		1.015	.051	.861	.103	11903
	60 to 71 ft.	414		A	38.910	25.656	30.312	5.122	.377	.000	.267	.110	6479
				B		41.998	49.618	8.384	.617	.000	.438	.180	10605
				C		45.841	54.159		.674	.000	.478	.196	11575
SH-7160 7N 54E S21 DCBB	80 to 88 ft.	415	Dominy (M)	A	37.270	27.143	31.084	4.504	.204	.021	.042	.141	6792
				B		43.269	49.551	7.180	.325	.034	.067	.224	10828
				C		46.616	53.384		.350	.036	.073	.242	11665
SH-7161 7N 54E S29 CCAB	35 to 42 ft.	416	Dominy (M)	A	37.820	26.366	28.982	6.832	.220	.021	.055	.144	6449
				B		42.403	46.610	10.987	.353	.033	.088	.232	10371
				C		47.637	52.363		.397	.037	.099	.261	11651
	55 to 64 ft.	417	(L)	A	35.230	27.299	32.180	5.290	.606	.015	.395	.197	7154
				B		42.148	49.684	8.168	.936	.023	.609	.305	11045
				C		45.897	54.103		1.020	.025	.663	.332	12027
SH-7162 7N 54E S32 ACDD	100 to 107 ft.	418	Dominy (M)	A	34.390	27.588	32.220	5.802	.518	.030	.244	.244	7271
				B		42.048	49.109	8.843	.790	.045	.372	.372	11083
				C		46.127	53.873		.866	.049	.408	.408	12158
	111 to 121 ft.	419	(L)	A	37.260	24.508	29.148	9.084	.182	.014	.035	.133	6354
				B		39.063	46.458	14.479	.290	.022	.056	.212	10128
				C		45.676	54.324		.339	.026	.065	.248	11843
SH-7163 6N 54E S5 CADB	90 to 98 ft.	420	Dominy (U)	A	42.130	23.833	29.117	4.920	.299	.006	.104	.188	6718
				B		41.184	50.314	8.502	.516	.011	.179	.325	11609
				C		45.011	54.989		.564	.012	.196	.355	12688
	98 to 110 ft.	421		A	39.700	24.960	30.282	5.058	.649	.014	.392	.243	6328
				B		41.393	50.219	8.388	1.077	.022	.650	.404	10493
				C		45.183	54.817		1.175	.024	.710	.441	11454
	110 to 111 ft.	422		A	37.730	24.607	27.179	10.484	.564	.069	.124	.371	6297
				B		39.516	43.648	16.836	.906	.110	.199	.597	10113
				C		47.516	52.484		1.089	.133	.239	.717	12160
SH-7164 6N 53E S2 DACA	42 to 51 ft.	423	Dominy (M)	A	37.360	26.236	30.719	5.684	.733	.021	.426	.286	6955
				B		41.884	49.041	9.075	1.171	.033	.680	.457	11104
				C		46.064	53.936		1.287	.037	.748	.503	12212
	57 to 67 ft.	425	(L)	A	34.500	28.021	28.447	9.032	.426	.014	.036	.375	6862
				B		42.780	43.430	13.790	.650	.022	.055	.573	10476
				C		49.623	50.377		.754	.026	.064	.664	12152
SH-7165 7N 54E S31 CAAA	50 to 56 ft.	426	Dominy (M)	A	39.580	24.769	29.805	5.846	.567	.020	.324	.223	6554
				B		40.994	49.330	9.676	.939	.034	.536	.369	10848
				C		45.386	54.614		1.039	.037	.594	.408	12010
	68 to 74 ft.	427	(L)	A	35.070	25.257	29.845	9.828	.325	.007	.036	.282	6497
				B		38.898	45.965	15.136	.501	.011	.056	.434	10006
				C		45.836	54.164		.390	.013	.066	.511	11790

U = Upper bench of Dominy
M = Middle bench of Dominy
L = Lower bench of Dominy

SH-7166 A 7N 53E S36 DCDD	110 to 118 ft.	428	Dominy (U)	A	36.150	24.999	32.222	6.629	.229	.007	.072	.150	6842
				B		39.152	50.465	10.382	.359	.011	.112	.235	10715
				C		43.688	56.312		.400	.013	.125	.263	11957
	118 to 120 ft.	429		A	40.040	22.130	32.881	4.949	.122	.007	.020	.095	6351
				B		36.909	54.838	8.253	.203	.011	.034	.158	10592
				C		40.229	59.771		.222	.012	.037	.172	11544
SH-7172 7N 54E S8 ADBB	50 to 58 ft.	430	Dominy (U)	A	38.690	25.069	31.375	4.866	.340	.029	.116	.196	6785
				B		40.888	51.175	7.937	.555	.047	.189	.319	11066
				C		44.413	55.587		.603	.051	.205	.346	12021
	58 to 66 ft.	431		A	38.370	24.606	32.359	4.665	.199	.031	.031	.138	6850
				B		39.925	52.505	7.570	.323	.050	.050	.224	11115
				C		43.195	56.805		.350	.054	.054	.242	12025
	66 to 74 ft.	432		A	38.280	26.313	31.528	3.879	.505	.090	.130	.285	7143
				B		42.633	51.083	6.285	.819	.145	.211	.462	11574
				C		45.492	54.508		.873	.155	.225	.493	12350
	91 to 98 ft.	433	(M)	A	39.590	24.294	31.197	4.919	.363	.015	.139	.208	6704
				B		40.215	51.643	8.143	.601	.026	.230	.345	11098
				C		43.780	56.220		.654	.028	.250	.376	12082
	124 to 131 ft.	434	(L)	A	38.730	24.138	32.201	4.932	.213	.009	.026	.179	6681
				B		39.396	52.555	8.049	.348	.014	.042	.292	10904
				C		42.844	57.156		.379	.015	.045	.318	11858
SH-7173 7N 54E S5 DDAD	32 to 37 ft.	435	Dominy (L)	A	34.500	24.795	30.391	10.314	.201	.015	.015	.171	6583
				B		37.855	46.399	15.746	.307	.023	.023	.261	10050
				C		44.930	55.070		.364	.027	.027	.310	11928
SH-7176 6N 54E S9 CBBC	60 to 69 ft.	436	Dominy (M & L)	A	36.000	25.537	29.575	8.889	.775	.037	.465	.273	6737
				B		39.901	46.211	13.889	1.211	.058	.727	.427	10526
				C		46.336	53.664		1.407	.067	.844	.496	12224
	69 to 71 ft.	437		A	34.120	27.857	29.621	8.402	.185	.022	.007	.156	6815
				B		42.285	44.962	12.753	.281	.034	.011	.236	10344
				C		48.466	51.534		.322	.039	.013	.271	11656
SH-7177 6N 54E S16 ABAC	42 to 50 ft.	456	Dominy (M & L)	A	36.400	25.875	30.864	6.861	.325	.038	.166	.121	6793
				B		40.684	48.528	10.788	.510	.059	.261	.190	10680
				C		45.603	54.397		.572	.067	.293	.213	11972
	50 to 56 ft.	457		A	36.100	25.680	28.957	9.263	.890	.023	.629	.238	6780
				B		40.187	45.316	14.497	1.393	.036	.985	.372	10610
				C		47.001	52.999		1.629	.042	1.152	.435	12409
SH-7178 6N 54E S16 CBAD	60 65 ft.	438	Local	A	38.770	24.641	30.513	6.076	.374	.028	.000	.345	6587
				B		40.244	49.833	9.923	.610	.046	.000	.564	10759
				C		44.677	55.323		.677	.051	.000	.626	11944
SH-7178 A 6N 54E S16 CDDA	20 to 30 ft.	439	Dominy (M & L)	A	37.530	25.408	30.112	6.950	.325	.041	.166	.117	6629
				B		40.672	48.203	11.125	.520	.066	.265	.188	10612
				C		45.763	54.237		.585	.075	.299	.212	11940
	30 to 34 ft.	440		A	36.850	26.052	30.174	6.924	.184	.014	.007	.162	6671
				B		41.254	47.781	10.965	.291	.022	.011	.257	10563
				C		46.334	53.666		.326	.025	.013	.289	11864

U= Upper bench of Dominy
M = Middle bench of Dominy
L = Lower bench of Dominy

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[1] /A, as received; B, moisture free; C, moisture and ash free.

Table 91.–Major ash constituents, Knowlton coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7158 7N 54E S16 BBBB	22 to 32 ft.	412	Dominy (L)	17.3	21.8	6.4	.2	6.3	.4	.1	27.2	14.9	.6	95.2
SH-7159 7N 54E S21 DADB	51 to 71 ft.	413-414	Dominy (U)	10.7	30.8	6.4	.2	10.3	1.1	.8	14.9	15.2	.4	90.8
SH-7160 7N 54E S21 DCBB	80 to 88 ft.	415	Dominy (M)	12.4	22.2	13.2	.2	10.0	.5	.2	14.4	21.4	.4	94.9
SH-7161 7N 54E S29 CCAB	35 to 42 ft.	416	Dominy (M)	10.0	20.2	14.7	.2	6.4	.8	.1	13.2	26.5	.2	92.3
	55 to 64 ft.	417	(L)	19.9	22.1	3.6	.2	6.1	1.4	.1	32.6	7.0	.4	93.4
SH-7162 7N 54E S32 ACDD	100 to 121 ft.	418-419	Dominy (M & L)	18.7	16.9	4.7	.8	5.1	1.2	.1	36.5	8.7	.6	93.3
SH-7163 6N 54E S5 CADB	90 to 111 ft.	420-422	Dominy (U)	10.5	30.4	4.8	.1	12.4	.7	.4	18.5	14.3	.5	92.6
SH-7164 6N 53E S2 DACA	42 to 67 ft.	423, 425	Dominy (M & L)	15.3	21.5	6.2	.3	6.1	2.0	.1	32.4	11.3	.8	96.0
SH-7165 7N 54E S31 CAAA	50 to 56 ft.	426	Dominy (M)	19.3	21.4	5.2	.5	7.3	.8	.1	34.0	8.5	.8	97.9

SH-7166 A 7N 53E S36 DCDD	110 to 120 ft.	428-429	Dominy (U)	11.2	31.2	2.3	.1	11.4	.3	.1	31.3	7.7	.8	96.4
SH-7172 7N 54E S8 ADBB	50 to 74 ft.	430-432	Dominy (U)	8.9	28.7	6.6	.3	10.9	1.9	.3	16.8	18.2	.3	92.9
	91 to 98 ft.	433	(M)	12.5	24.9	11.7	.2	8.8	1.1	.4	14.6	20.8	.2	95.2
	124 to 131 ft.	434	(L)	18.9	22.0	4.7	.3	9.5	2.9	.3	29.4	8.2	.5	96.7
SH-7173 7N 54E S5 DDAD	32 to 37 ft.	435	Dominy (L)	13.7	7.7	3.2	.9	4.1	.9	.1	59.4	3.8	.7	94.5
SH-7176 6N 54E S9 CBBC	60 to 71 ft.	436-437	Dominy (M & L)	15.7	21.3	8.7	.2	6.2	.6	.1	27.8	15.5	.5	96.6
SH-7177 6N 54E S16 ABAC	42 to 56 ft.	456-457	Dominy (M & L)	17.2	20.7	7.1	.2	7.1	1.2	.1	28.2	14.2	.6	96.6
SH-7178 6N 54E S16 CBAD	60 to 65 ft.	438	Local	11.4	22.0	4.5	.2	6.9	1.9	.1	36.3	11.5	.8	95.6
SH-7178 A 6N 54E S16 CDDA	20 to 34 ft.	439-440	Dominy (M & L)	19.1	22.1	4.7	.2	9.3	.9	.1	31.9	8.3	.7	97.3

U = Upper bench of Dominy
M = Middle bench of Dominy
L = Lower bench of Dominy

COAL BEDS

The coal beds in the Knowlton coal deposit that carry economically recoverable reserves are the three benches of the Dominy coal bed, low in the Tongue River Member of the Fort Union Formation. The upper bench maintains a thickness of 25 feet or more. In the northern part of the area its base is 10 feet above the middle bench, and in the southern part of the deposit it is 81 feet above the combined middle and lower benches (Pl. 32B). In the northern part of the deposit the middle bench is 23 feet above the lower bench, but in the southeastern part of the area, these two benches join to form a single bench 17 feet thick, as shown in drill hole SH-7163, sec. 5, T. 6 N., R. 54 E.

The three benches of the Dominy bed are shown in drill hole SH-7172, sec. 8, T. 7 N., R. 54 E. The upper bench is 28 feet thick; 11 feet below it is the middle bench, which is 12 feet thick; 23 feet below that is the lower bench which is 10 feet thick. In drill hole SH-7166 A, sec. 36, T. 7 N., R. 53 E., the upper bench is 31 feet thick; 20 feet below it is the middle bench, which is 9 feet thick; 14 feet below that is the lower bench, which is 11 feet thick. Another coal bed below the Dominy has been drilled in the southeastern corner of the deposit, in sec. 16, T. 6 N., R. 54 E. In drill hole SH-7177 it is 6 feet thick, and in drill hole SH-7178, it is 5 feet thick.

COAL QUALITY

Thirty core samples of the benches of the Dominy coal bed were taken during the 1971 core-drilling program and were analyzed by the Montana Bureau of Mines and Geology analytical laboratory. Proximate analysis, forms of sulfur, and heating values are shown in Table 90, and major ash constituents are shown in Table 91.

COAL RESERVES

The coal reserves in the three benches of the Dominy coal bed in the Knowlton area total 867,820,000 tons (Table 89).

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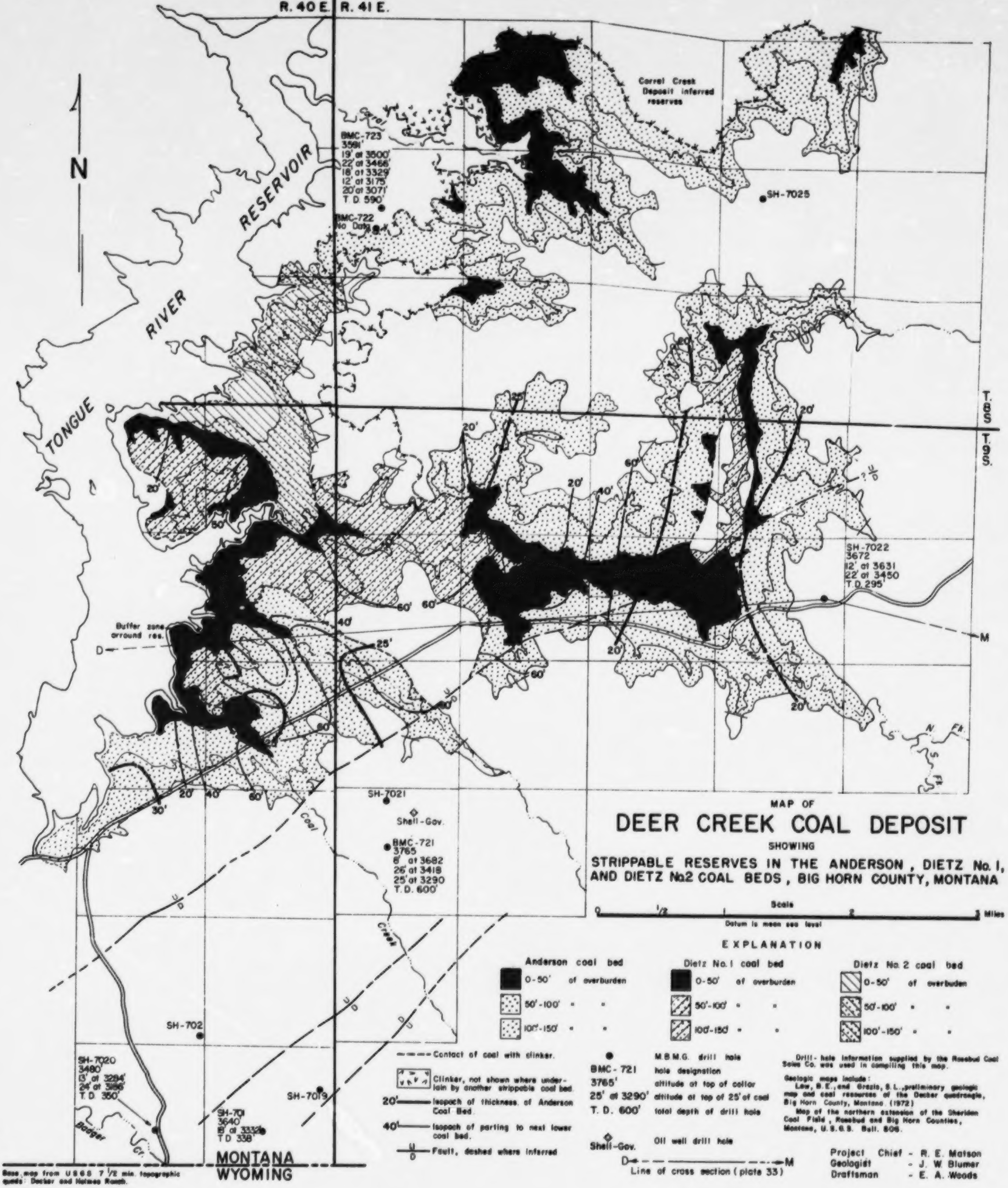

R. 40 E.
R. 41 E.
N
RESERVOIR
RIVER
TONGUE
Carrol Creek Deposit inferred reserves
Carrol
BMC-723
3591'
19' at 3600'
22' at 3466'
18' at 3329'
12' at 3175'
20' at 3071'
T. D. 590'
BMC-722
No Data
SH-7025
T. 8 S.
T. 9 S.
SH-7022
3672
12' at 3631
22' at 3450
T. D. 295'
Buffer zone arround res.
D
M
20'
25'
30'
40'
60'
50
N. Fk.
S. Fk.
U
D
SH-7021
Shell-Gov.
BMC-721
3765
8' at 3682
26' at 3418
25' at 3290
T. D. 600'
Coal
Creek
SH-702
SH-7019
SH-7020
3480
13' at 3294'
26' at 3186
T. D. 350'
SH-701
3640
18' at 3332
T D 338
Badger
Cr.
MONTANA
WYOMING

MAP OF

DEER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE ANDERSON, DIETZ No. 1, AND DIETZ No. 2 COAL BEDS, BIG HORN COUNTY, MONTANA

Scale
0 ½ 1 2 3 Miles
Datum is mean sea level

EXPLANATION

Anderson coal bed	Dietz No. 1 coal bed	Dietz No. 2 coal bed
■ 0-50' of overburden	■ 0-50' of overburden	▨ 0-50' of overbuden
▒ 50'-100' " "	▨ 50'-100' " "	▩ 50'-100' " "
▒ 100'-150' " "	▨ 100'-150' " "	▩ 100'-150' " "

– – – – Contact of coal with clinker.

Clinker, not shown where underlain by another strippable coal bed.

20' —— Isopach of thickness of Anderson Coal Bed.

40' —— Isopach of parting to next lower coal bed.

U/D Fault, dashed where inferred

●	M.B.M.G. drill hole
BMC-721	hole designation
3765'	altitude at top of collar
25' at 3290'	altitude at top of 25' of coal
T. D. 600'	total depth of drill hole
◇ Shell-Gov.	Oil well drill hole

D – – —— – – M
Line of cross section (plate 33)

Drill-hole information supplied by the Rosebud Coal Sales Co. was used in compiling this map.

Geologic maps include:
Law, B. E., and Grazis, S. L., preliminary geologic map and coal resources of the Decker quadrangle, Big Horn County, Montana (1972)
Map of the northern extension of the Sheridan Coal Field, Rosebud and Big Horn Counties, Montana, U.S.G.S. Bull. 806.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

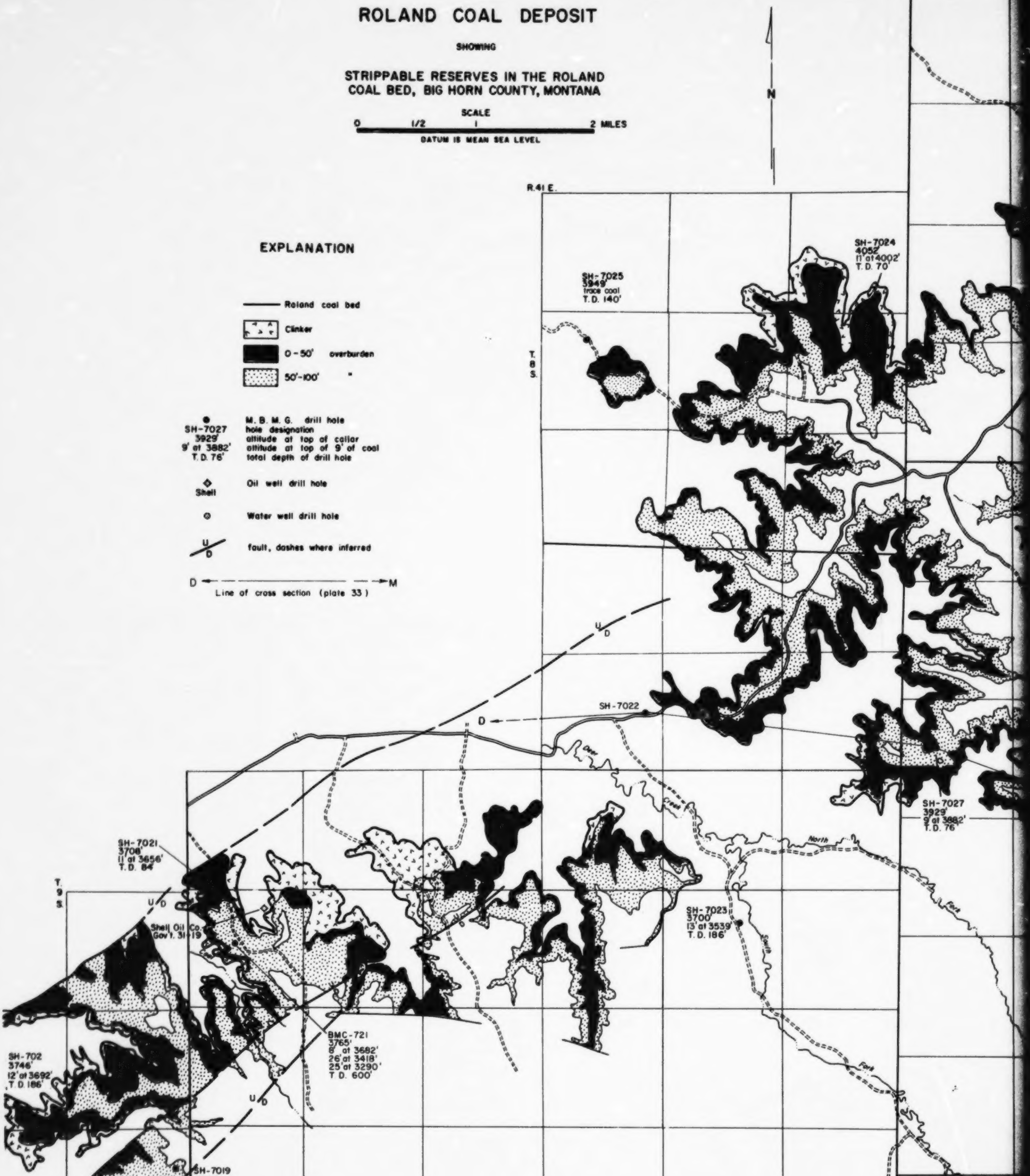
Base map from U.S.G.S. 7 ½ min. topographic quads: Decker and Holmes Ranch.

MAP OF

ROLAND COAL DEPOSIT

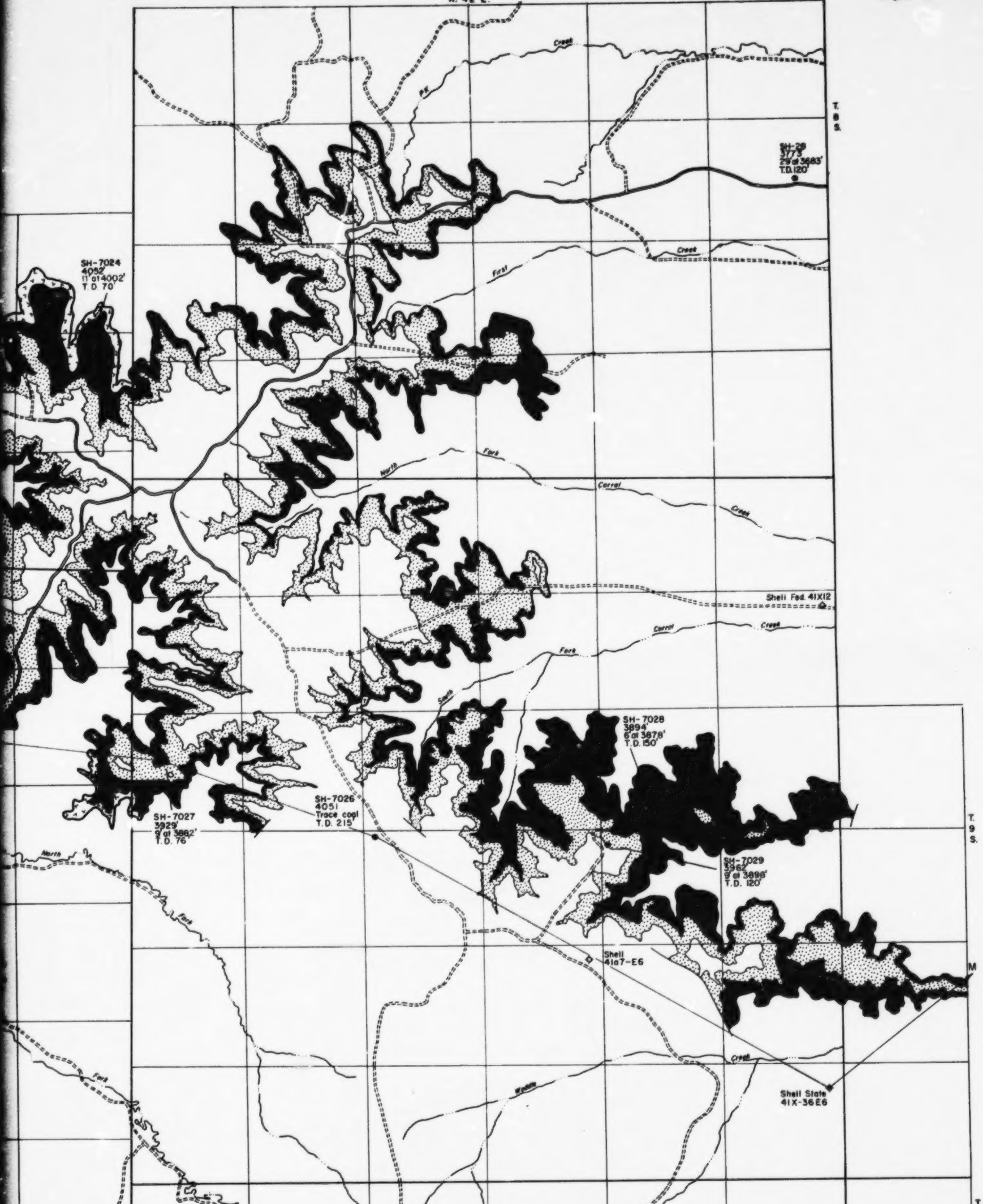
SHOWING

STRIPPABLE RESERVES IN THE ROLAND COAL BED, BIG HORN COUNTY, MONTANA


SCALE
0
1/2
1
2 MILES
DATUM IS MEAN SEA LEVEL
N
R.41 E.
T. 8 S.
T. 9 S.
T. 40 E.
EXPLANATION
Roland coal bed
Clinker
0 - 50' overburden
50'-100' "
M. B. M. G. drill hole
SH-7027 hole designation
3929' altitude at top of collar
9' at 3882' altitude at top of 9' of coal
T. D. 76' total depth of drill hole
Shell Oil well drill hole
Water well drill hole
U D fault, dashes where inferred
D M Line of cross section (plate 33)
SH-7025 3949' trace coal T. D. 140'
SH-7024 4052' 11' at 4002' T. D. 70'
SH-7022
D
U D
Deer Creek
North Fork
SH-7027 3929' 9' at 3882' T. D. 76'
SH-7021 3708' 11' at 3656' T. D. 84'
Shell Oil Co. Gov't. 31-19
SH-7023 3700' 13' at 3539' T. D. 186'
BMC-721 3765' 8' at 3682' 26' at 3418' 25' at 3290' T. D. 600'
SH-702 3746' 12' at 3692' T. D. 186'
SH-7019 3707' 8' at 3637' T. D. 100'
SH-7020
SH-701
MONTANA
WYOMING

Base map from USGS Bulletin 806 Plate 29 and advance topographic quadrangle maps: Lacey Gulch, Decker, Holmes Ranch, Spring Gulch.

BULLETIN 91 PLATE 3

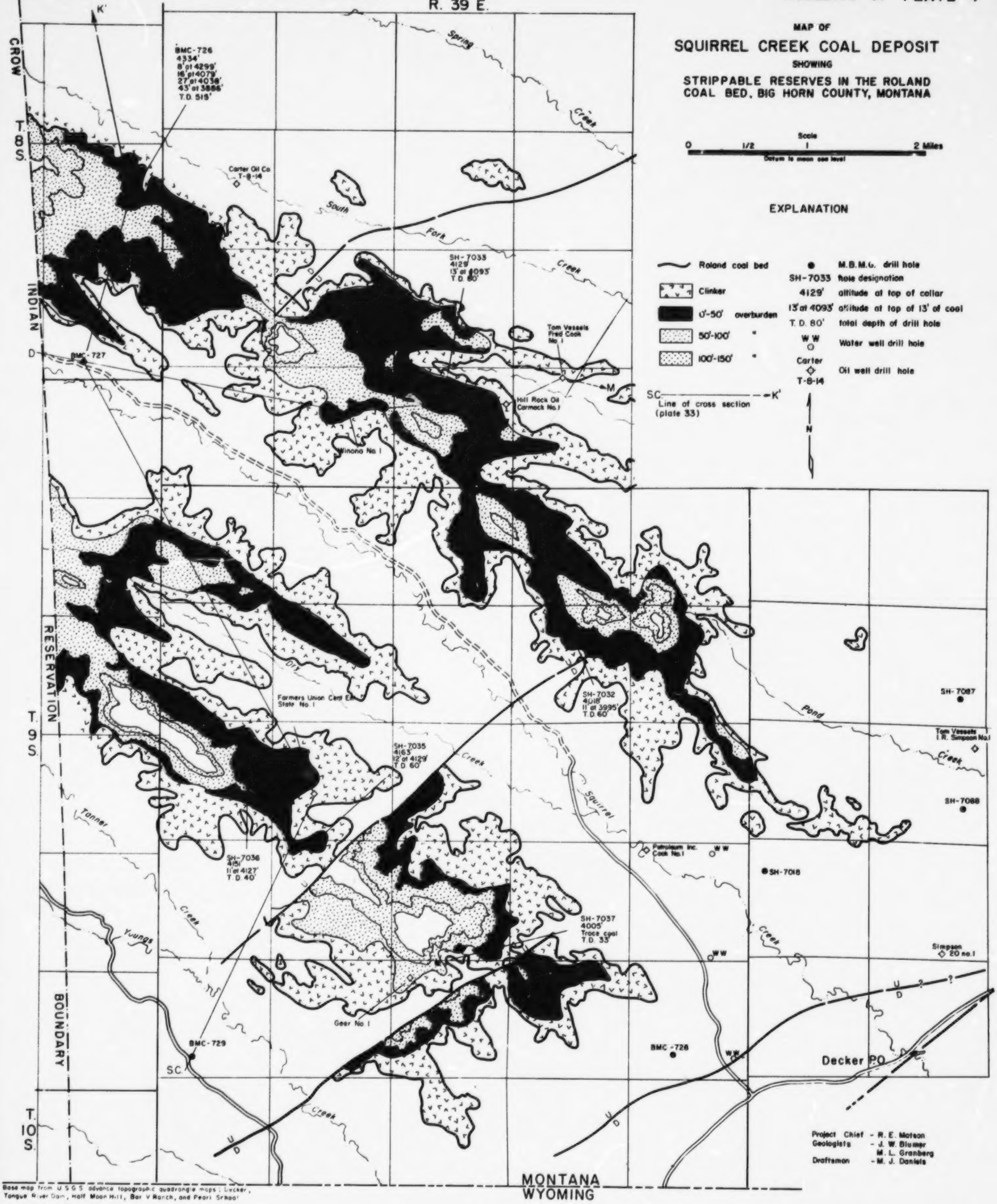

R. 42 E.
T. 8 S.
T. 9 S.
T. 10 S.
Creek
Fk
SH-28
3773'
29' at 3683'
T.D. 120'
First
Creek
SH-7024
4052'
11' at 4002'
T.D. 70'
North
Fork
Corral
Creek
Shell Fed. 41X12
Corral
Creek
Fork
South
SH-7028
3894'
6' at 3878'
T.D. 150'
SH-7027
3929'
9' at 3882'
T.D. 76'
SH-7026
4051
Trace coal
T.D. 215'
SH-7029
3962
9' at 3896'
T.D. 120'
North
Fork
Shell
41a7-E6
M
Fork
Creek
Middle
Shell State
41X-36E6

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Geologist - M. L. Grasberg
Draftsman - H. J. Denton

MONTANA BUREAU OF MINES AND GEOLOGY

BULLETIN 91 PLATE 4

MAP OF
SQUIRREL CREEK COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE ROLAND COAL BED, BIG HORN COUNTY, MONTANA


R. 39 E.
CROW
INDIAN
RESERVATION
BOUNDARY
T. 8 S.
T. 9 S.
T. 10 S.
K'
BMC-726
4334'
8' at 4299'
16' at 4079'
27' at 4038'
43' at 3886'
T.D. 515'
Spring
Creek
Carter Oil Co.
T-8-14
South
Fork
Creek
SH-7033
4129'
13' at 4093'
T.D. 80'
Tom Vessels
Fred Cook
No. 1
Hill Rock Oil
Carmack No. 1
M
D
BMC-727
Winona No. 1
Dry
Farmers Union Cent Ex
State No. 1
SH-7032
4018'
11' at 3995'
T.D. 60'
Pond
Creek
SH-7087
Tom Vessels
I.R. Simpson No. 1
SH-7088
SH-7035
4163'
12' at 4129'
T.D. 60'
Squirrel
Creek
Tanner
SH-7036
4151'
11' at 4127'
T.D. 40'
Petroleum Inc.
Cook No. 1
WW
SH-7016
Youngs
Creek
SH-7037
4005'
Trace coal
T.D. 33'
Simpson
20 no. 1
Geer No. 1
U
D
?
BMC-729
SC
BMC-728
Decker P.O.
Creek
MONTANA
WYOMING

Scale

0 1/2 1 2 Miles

Datum is mean sea level

EXPLANATION

〰	Roland coal bed
▨	Clinker
■	0'-50' overburden
▨	50'-100' "
▨	100'-150' "

SC - - - K'
Line of cross section
(plate 33)

●	M.B.M.G. drill hole
SH-7033	hole designation
4129'	altitude at top of collar
13' at 4093'	altitude at top of 13' of coal
T. D. 80'	total depth of drill hole
W W ○	Water well drill hole
Carter ◇ T-8-14	Oil well drill hole

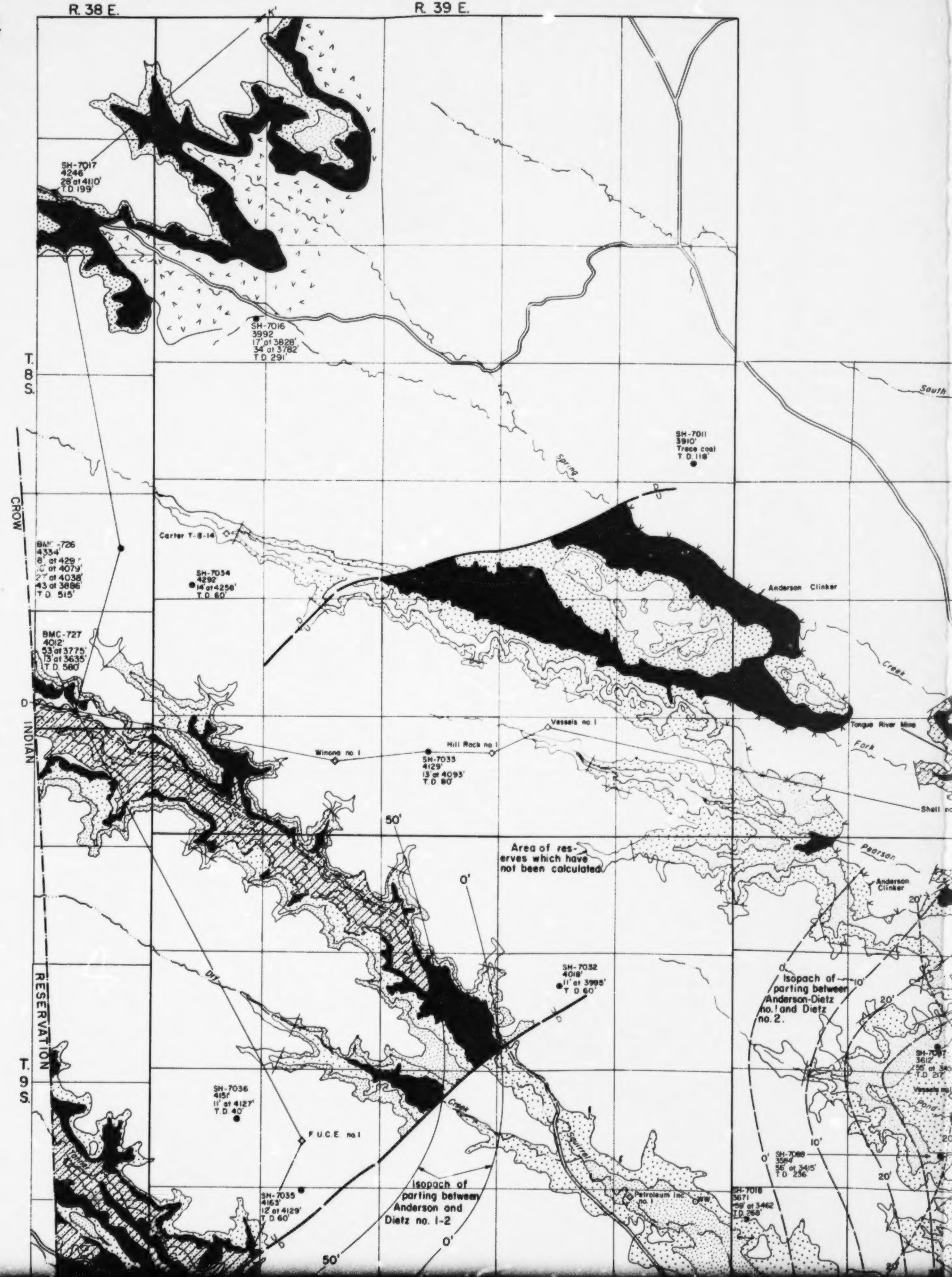
N

Project Chief - R. E. Matson
Geologists - J. W. Blumer
M. L. Granberg
Draftsman - M. J. Daniels

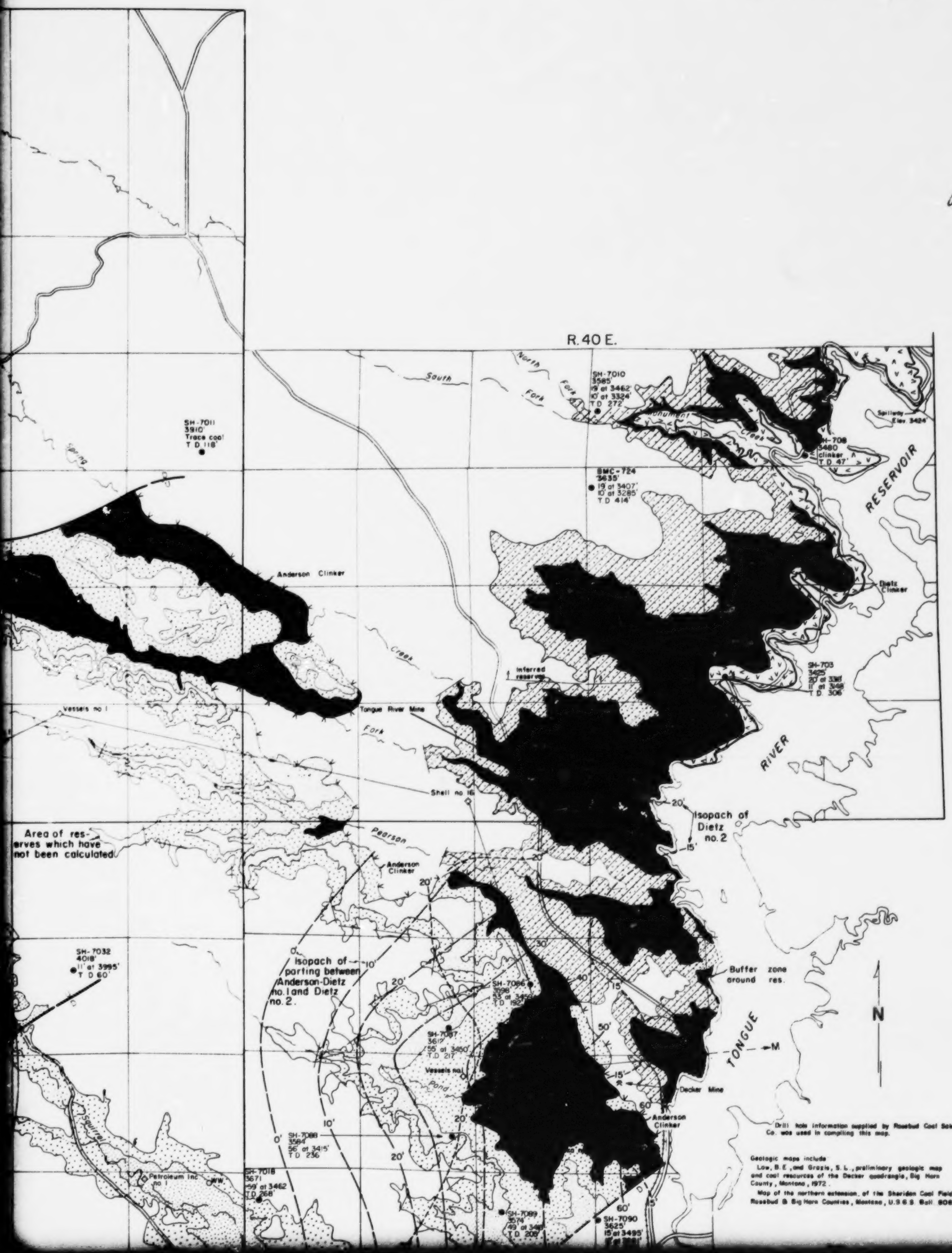
Base map from U.S.G.S. advance topographic quadrangle maps: Decker, Tongue River Dam, Half Moon Hill, Bar V Ranch, and Pearl School

A

MONTANA BUREAU OF MINES AND GEOLOGY


R. 38 E.
R. 39 E.
K'
T. 8 S.
T. 9 S.
CROW
INDIAN
RESERVATION
SH-7017
4246
28' at 4110'
T.D. 199'
SH-7016
3992
17' at 3828'
34' at 3782'
T.D. 291'
SH-7011
3910'
Trace coal
T.D. 118'
Spring
Creek
Fork
South
Pearson
BMC-726
4334'
8' at 4291'
10' at 4079'
27' at 4038'
43' at 3886'
T.D. 515'
BMC-727
4012'
53' at 3775'
13' at 3635'
T.D. 580'
Carter T-8-14
SH-7034
4292
14' at 4258'
T.D. 60'
D
D'
Anderson Clinker
Tongue River Mine
Winona no. 1
Hill Rock no. 1
Vessels no. 1
SH-7033
4129'
13' at 4093'
T.D. 60'
Shell no
50'
0'
Area of reserves which have not been calculated
Anderson Clinker
20'
SH-7032
4018'
11' at 3995'
T.D. 60'
Isopach of parting between Anderson-Dietz no. 1 and Dietz no. 2.
10'
20'
0
SH-7036
4151'
11' at 4127'
T.D. 40'
F.U.C.E. no. 1
Dry
Creek
Squirrel
SH-7035
4153'
12' at 4129'
T.D. 60'
Isopach of parting between Anderson and Dietz no. 1-2
50'
0'
Petroleum Inc. no. 1
WW
SH-7018
3671
59' at 3462
T.D. 268'
SH-7088
3564
56' at 3415'
T.D. 236
SH-7087
3612
55' at 34
T.D. 21
Vessels no
Pond
10'
0'
20'
20'

B

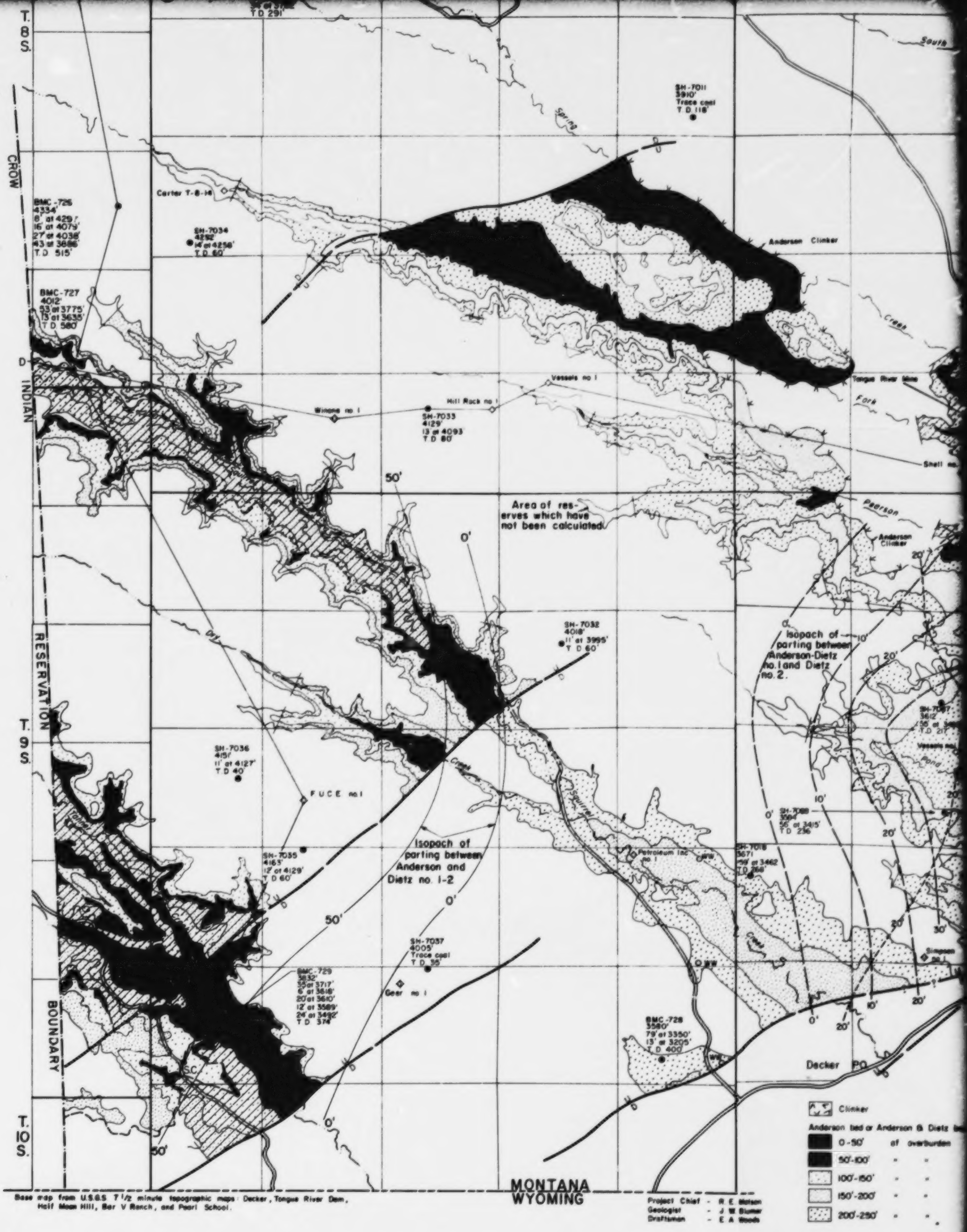

R. 40 E.
South Fork
North Fork
SH-7010
3585'
19' at 3462'
10' at 3324'
T D 272'
Monument Creek
SH-708
3480
clinker
T D 47'
Spillway Elev. 3424'
RESERVOIR
SH-7011
3910'
Trace coal
T D 118'
Spring
BMC-724
3635'
19' at 3407'
10' at 3285'
T D 414'
Dietz Clinker
Anderson Clinker
Creek
Inferred reserves
SH-703
3425
20' at 3381
11' at 3418
T D 306
Tongue River Mine
Fork
Vessels no. 1
RIVER
Shell no. 16
20'
Isopach of Dietz no. 2
15'
Area of reserves which have not been calculated
Pearson
Anderson Clinker
20'
30'
0
Isopach of parting between Anderson-Dietz no. 1 and Dietz no. 2.
10'
20'
SH-7032
4018'
11' at 3995'
T D 60'
SH-7086
3596
53' at 3459
T D 192
40
15
Buffer zone around res.
SH-7087
3617
55' at 3450'
T D 217'
50'
N
TONGUE
M
Vessels no. 1
Pond
15'
Decker Mine
60
Anderson Clinker
Squirrel
SH-7088
3584
56' at 3415'
T D 236
10'
0'
20'
20'
SH-7018
3671
59' at 3462
T D 268'
Petroleum Inc no. 1
WW
SH-7089
3574
49' at 348
T D 208'
60'
SH-7090
3625'
15' at 3495'
D
15'

Drill hole information supplied by Rosebud Coal Sales Co. was used in compiling this map.

Geologic maps include

Low, B.E., and Grazis, S.L., preliminary geologic map and coal resources of the Decker quadrangle, Big Horn County, Montana, 1972.

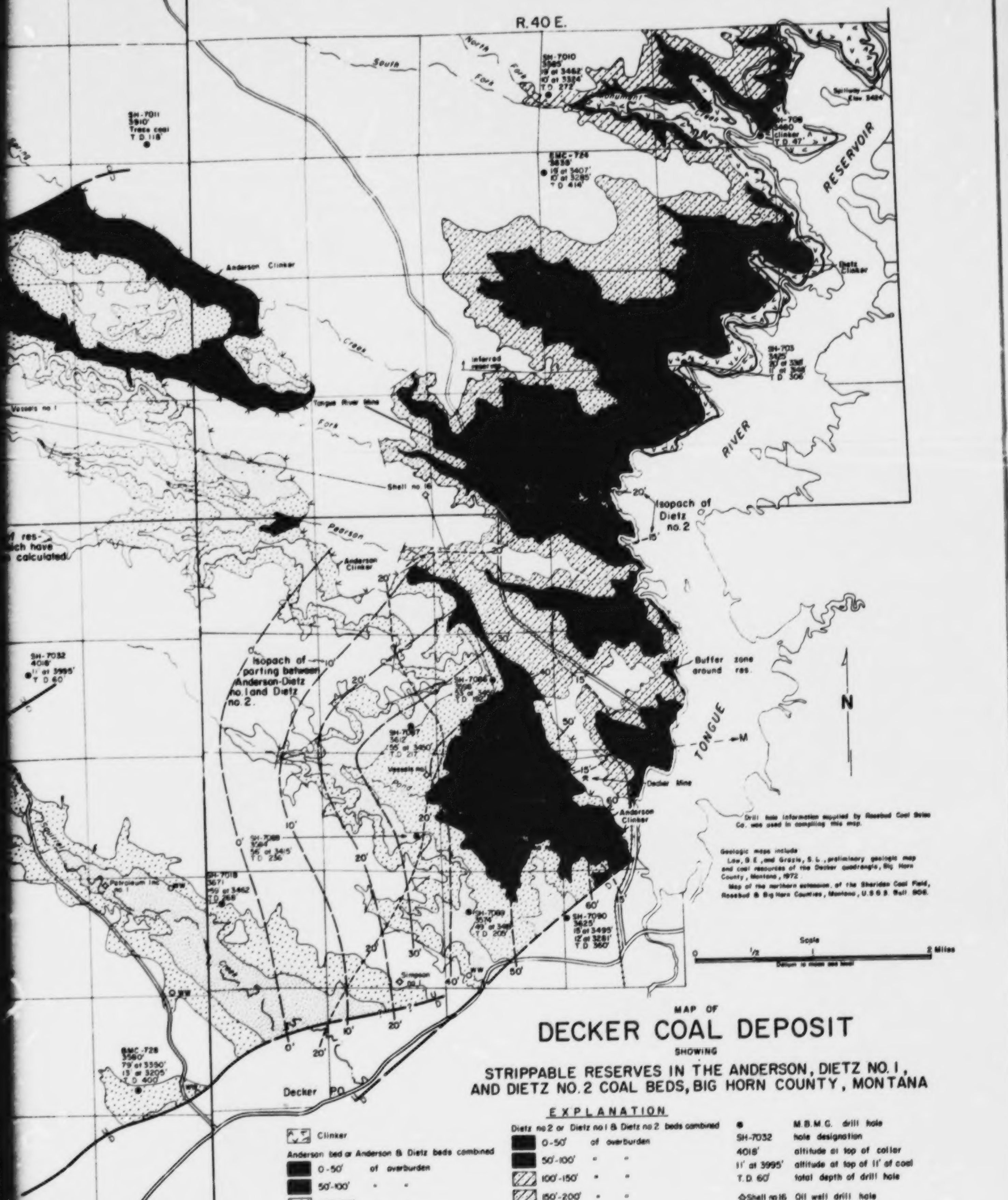
Map of the northern extension of the Sheridan Coal Field, Rosebud & Big Horn Counties, Montana, U.S.G.S. Bull. 806.


T. 8 S.
T. 9 S.
T. 10 S.
CROW INDIAN RESERVATION BOUNDARY
MONTANA
WYOMING
BMC-726
4334'
8' at 4297'
16' at 4079'
27' at 4038'
43' at 3886'
T.D. 515'
BMC-727
4012'
53' at 3775'
13' at 3635'
T.D. 580'
SH-7034
4292
14' at 4256'
T.D. 60'
Carter T-8-14
SH-7011
3910'
Trace coal
T.D. 118'
Anderson Clinker
Spring
Creek
Tongue River Mine
Fork
Shell no.
Winona no. 1
Hill Rock no. 1
Vessels no. 1
SH-7033
4129'
13' at 4093
T.D. 80'
Pearson
Area of reserves which have not been calculated
Anderson Clinker
50'
0'
SH-7032
4018'
11' at 3995'
T.D. 60'
Isopach of parting between Anderson-Dietz no. 1 and Dietz no. 2.
Dry
Creek
SH-7036
4151'
11' at 4127'
T.D. 40'
FUCE no. 1
SH-7035
4163'
12' at 4129'
T.D. 60'
Isopach of parting between Anderson and Dietz no. 1-2
Squirrel
Petroleum Inc. no. 1
SH-7038
3590'
56' at 3415'
T.D. 256'
SH-7018
3671'
Trace coal
T.D. 268'
Vessels no.
Pond
10'
20'
30'
0'
50'
SH-7037
4005'
Trace coal
T.D. 55'
Geer no. 1
BMC-729
3832'
35' at 3717'
6' at 3618'
20' at 3610'
12' at 3589'
24' at 3492'
T.D. 374'
SC
BMC-728
3580'
79' at 3350'
13' at 3205'
T.D. 400'
Simpson
Decker P.O.
Clinker
Anderson bed or Anderson & Dietz
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
200'-250' " "

Base map from U.S.G.S. 7 1/2 minute topographic maps: Decker, Tongue River Dam, Half Moon Hill, Bar V Ranch, and Pearl School.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

C


R. 40 E.
South
North Fork
Monument Creek
SH-7010 3565' 19' at 3462' 10' at 3324' T D 272'
SH-7011 3910' Trace coal T D 118'
EMC-724 3838' 19' at 3407' 10' at 3285' T D 414'
SH-709 3460 clinker T D 47'
Spillway Elev 3424'
RESERVOIR
Anderson Clinker
Dietz Clinker
Cree
Inferred reserves
SH-703 3425' 20' at 3391' 17' at 3281' T D 506'
Tongue River Mine
Vessels no 1
Fork
RIVER
Shell no 16
20'
Isopach of Dietz no. 2
15'
Pearson
of reserves which have been calculated
Anderson Clinker
Isopach of parting between Anderson-Dietz no. 1 and Dietz no. 2
SH-7032 4018' 11' at 3995' T D 60'
SH-7086
SH-7087 3612' 55' at 3480' T D 217'
Vessels no 1
Pond
Buffer zone around res.
TONGUE
N
M
Decker Mine
Anderson Clinker
SH-7088
SH-7018 3671 16' at 3462' T D 268'
Petroleum Inc. no 1
SH-7089
SH-7090 3625' 16' at 3495' 12' at 3281' T D 360'
Simpson Oil
EMC-728 3560' 79' at 3330' 13' at 3205' T D 400'
Decker PO
MONTANA
WYOMING
0'
10'
20'
30'
40'
50'
60'
Scale
0
1/2
1
2 Miles
Datum is mean sea level

Drill hole information supplied by Rosebud Coal Sales Co. was used in compiling this map.

Geologic maps include
Law, B. E., and Grazis, S. L., preliminary geologic map and coal resources of the Decker quadrangle, Big Horn County, Montana, 1972.
Map of the northern extension of the Sheridan Coal Field, Rosebud & Big Horn Counties, Montana, U.S.G.S. Bull. 806.

MAP OF

DECKER COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE ANDERSON, DIETZ NO. 1, AND DIETZ NO. 2 COAL BEDS, BIG HORN COUNTY, MONTANA

EXPLANATION

▨ Clinker

Anderson bed or Anderson & Dietz beds combined
■ 0-50' of overburden
■ 50'-100' " "
▨ 100'-150' " "
▨ 150'-200' " "
▨ 200'-250' " "

Dietz no 2 or Dietz no 1 & Dietz no 2 beds combined
■ 0-50' of overburden
■ 50'-100' " "
▨ 100'-150' " "
▨ 150'-200' " "
▨ 200'-250' " "

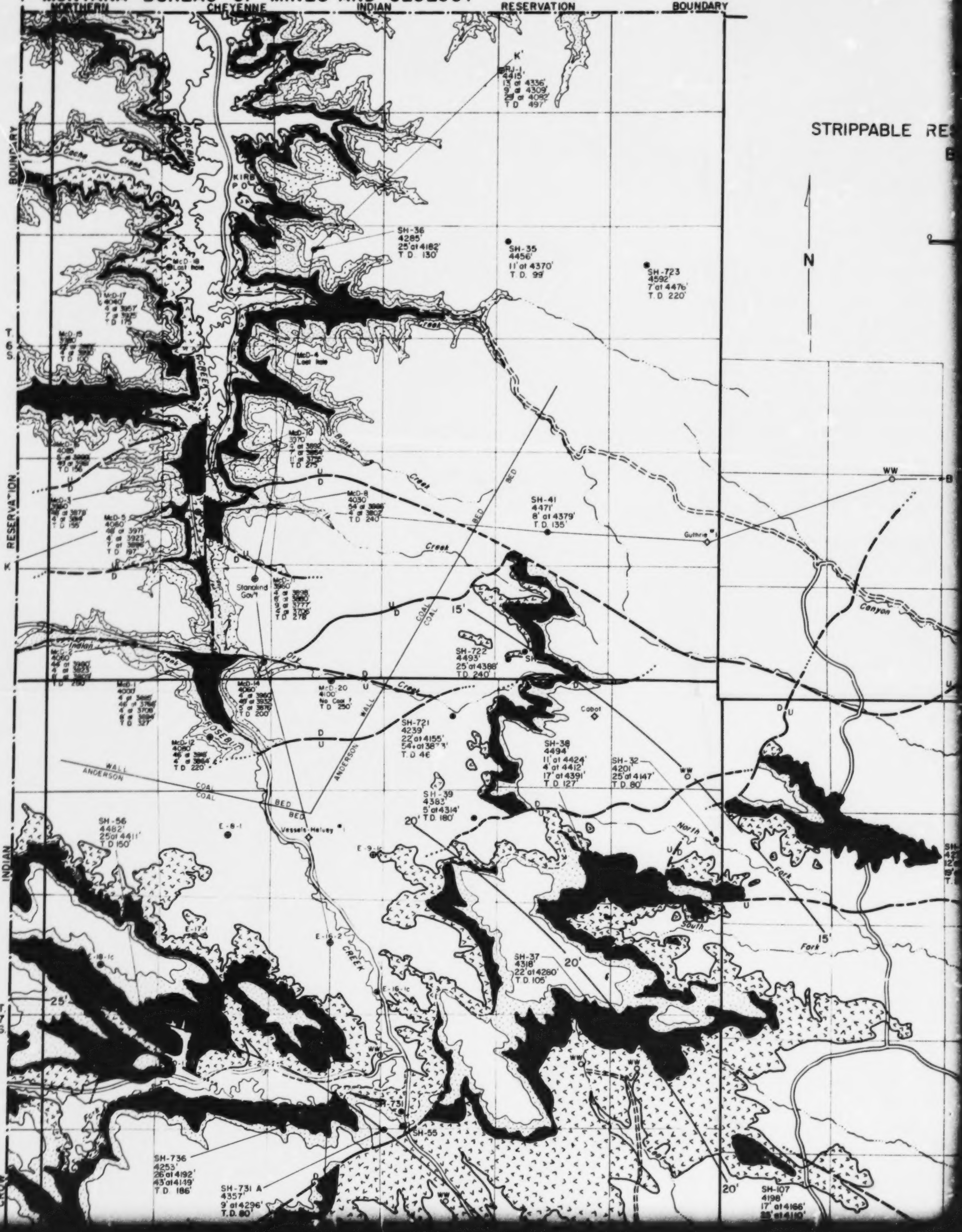
D —— Line of cross section (plate 33) → M

●	M.B.M.G. drill hole
SH-7032	hole designation
4018'	altitude at top of collar
11' at 3995'	altitude at top of 11' of coal
T.D. 60'	total depth of drill hole
◇Shell no 16	Oil well drill hole
○WW	Water well drill hole
U/D	Fault, dashed where inferred

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

D

MONTANA BUREAU OF MINES AND GEOLOGY



NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
STRIPPABLE RES
N
K'
RJ-1
4415'
13' at 4336'
9' at 4309'
29' at 4092'
T D 497'
BOUNDARY
RESERVATION
INDIAN
CROW
Cache Creek
ROSEBUD
KIRBY P.O.
SH-36
4285'
25' at 4182'
T D 130'
SH-35
4456'
11' at 4370'
T D 99'
SH-723
4592'
7' at 4476'
T D 220'
McD-18 Lost hole
McD-17
4040'
T D 175'
McD-15
T D 10
T. 6 S.
McD-4 Lost hole
CREEK
Bank Creek
McD-10
3970'
T D 275
McD-8
4030'
54' at 3986'
4' at 3807'
T D 240'
McD-3
T D 155'
McD-5
4060'
46' at 3971'
4' at 3923'
T D 197'
K
U
D
Stanolind Gov't
McD-11
3960
T D 278
COAL BED
15'
SH-41
4471'
8' at 4379'
T D 135'
Guthrie
WW
B
Canyon
Creek
Indian Creek
McD-2
4060
T D 280
Dry Creek
SH-722
4493'
25' at 4388'
T D 240'
McD-1
4000
T D 327
McD-14
4060'
5' at 3870'
T D 200'
McD-20
4100'
No Coal ?
T D 250'
ROSEBUD
McD-12
4080
T D 220
ANDERSON COAL BED
WALL
ANDERSON WALL
Cabot
SH-721
4239'
22' at 4155'
T.D 4€
SH-38
4494'
11' at 4424'
4' at 4412
17' at 4391'
T D 127'
SH-32
4201'
25' at 4147'
T D 80'
SH-39
4383'
5' at 4314'
T D 180'
20'
SH-56
4482'
25' at 4411'
T D 150'
E-8-1
Vessels-Helvey
E-9-1c
North Fork
South Fork
15'
E-17-1
E-16-2
E-18-1c
CREEK
E-16-1c
25'
T. 7 S.
SH-37
4318'
22' at 4280'
T D 105'
20'
E-2
SH-731
SH-55
SH-736
4253'
26' at 4192'
43' at 4149'
T D 186'
SH-731 A
4357'
9' at 4296'
T.D. 80'
SH-107
4198'
17' at 4166'
25' at 4110'
20'

BULLETIN 91 PLATE 5 A

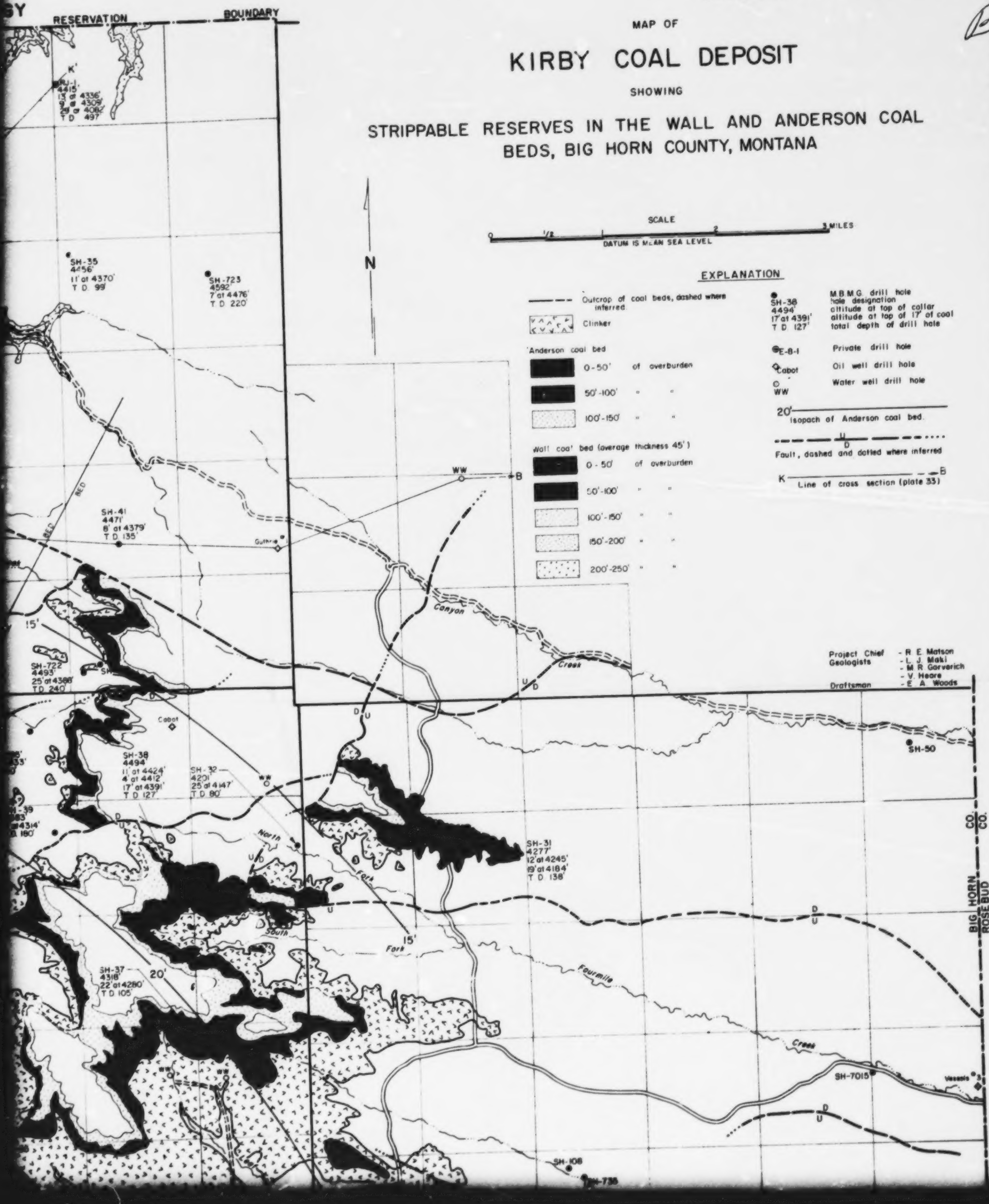
B

MAP OF

KIRBY COAL DEPOSIT

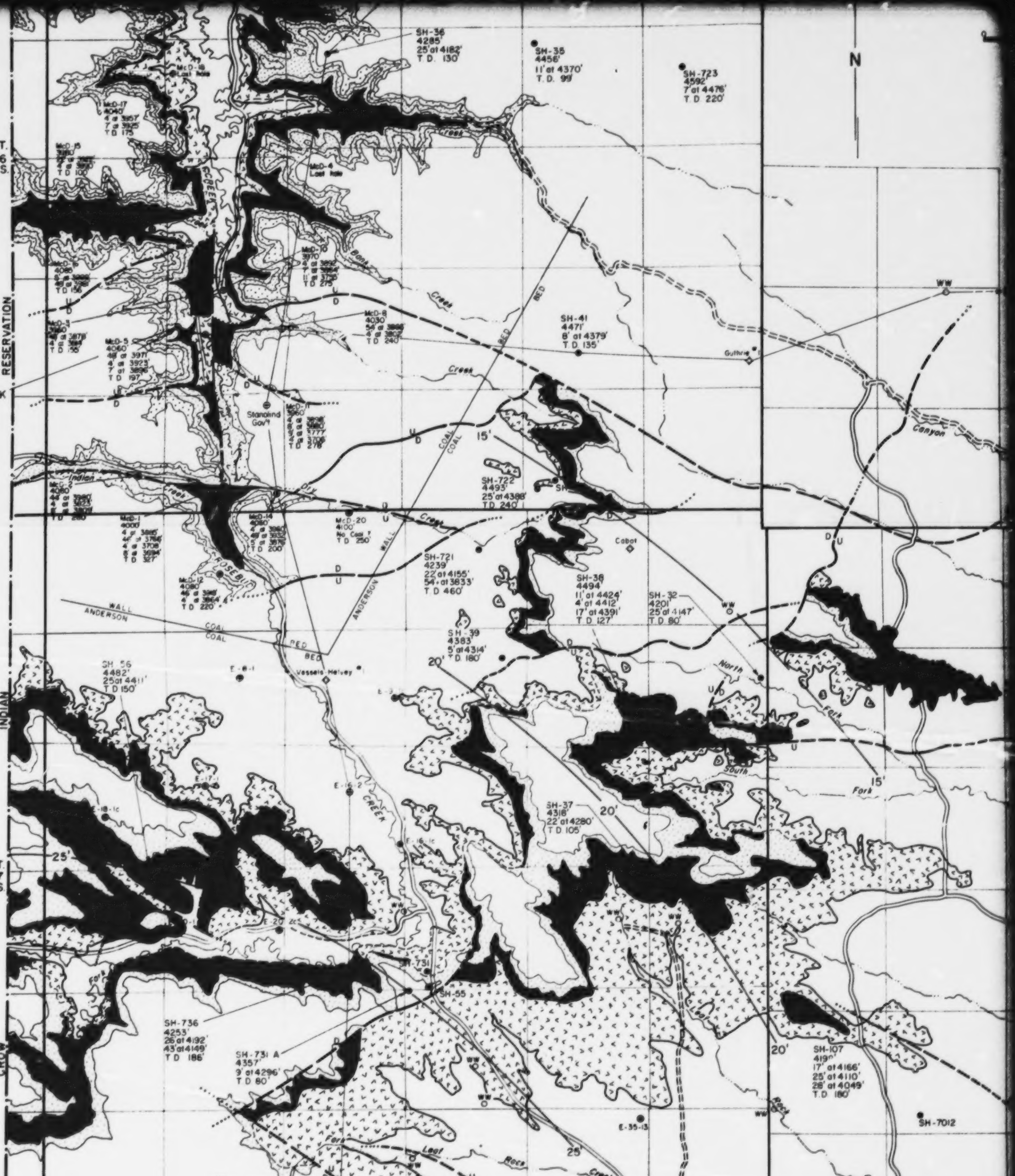
SHOWING

STRIPPABLE RESERVES IN THE WALL AND ANDERSON COAL BEDS, BIG HORN COUNTY, MONTANA



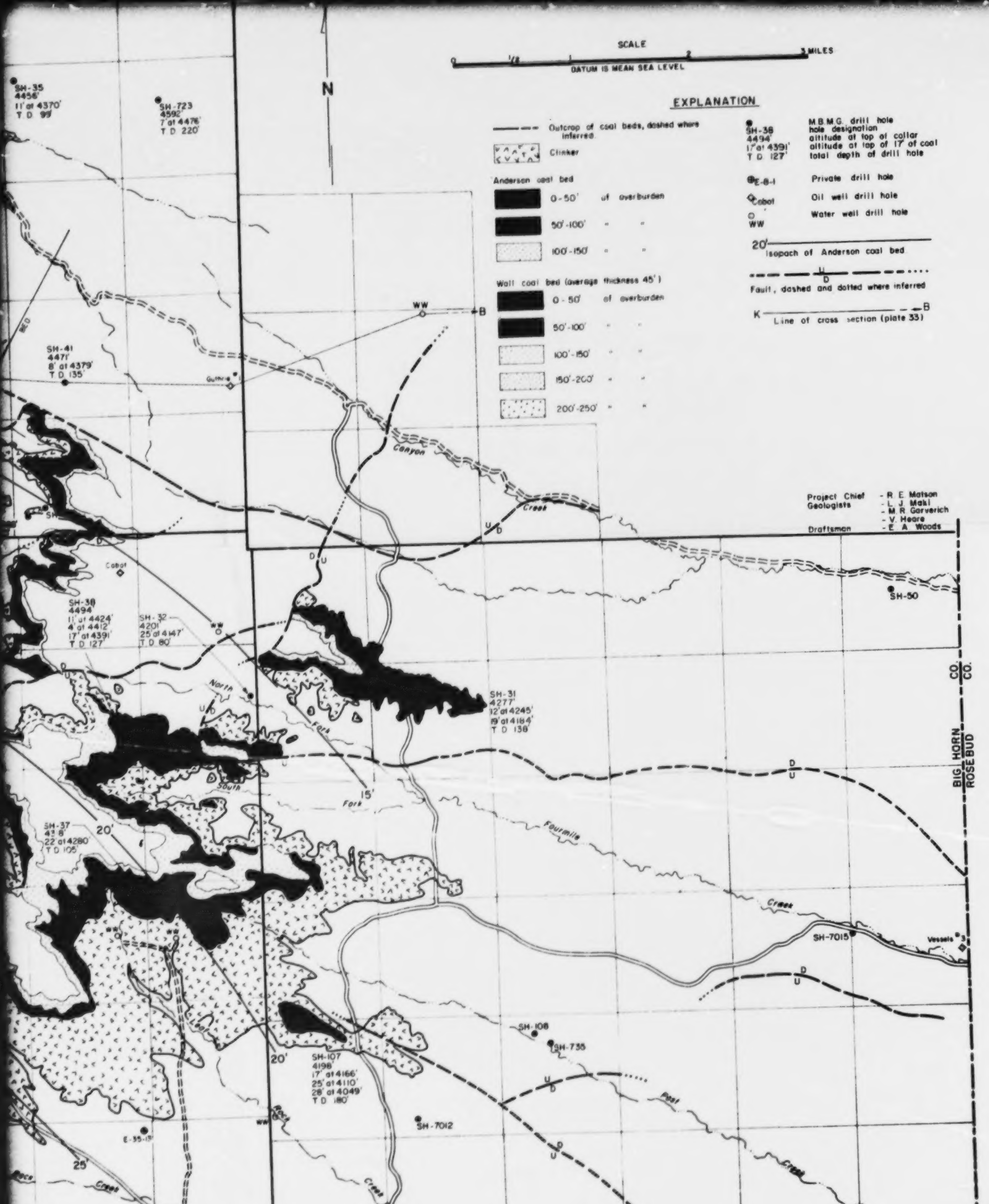
N
SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL
EXPLANATION
Outcrop of coal beds, dashed where inferred
Clinker
Anderson coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
Wall coal bed (average thickness 45')
0 - 50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
200'-250' " "
SH-38 4494' 17' at 4391' T D 127'
M.B.M.G. drill hole
hole designation
altitude at top of collar
altitude at top of 17' of coal
total depth of drill hole
E-8-1 Private drill hole
Cabot Oil well drill hole
WW Water well drill hole
20' Isopach of Anderson coal bed.
U D Fault, dashed and dotted where inferred
K B Line of cross section (plate 33)
GY
RESERVATION
BOUNDARY
K'
RJ-1 4415' 13' at 4336' 9' at 4309' 29' at 4082' T D 497'
SH-35 4456' 11' at 4370' T D 99'
SH-723 4592' 7' at 4476' T D 220'
BED
BED
SH-41 4471' 8' at 4379' T D 135'
WW
B
Guthrie
Canyon
Creek
15'
SH-722 4493' 25' at 4368' T D 240'
SH
Cabot
D
U
SH-38 4494 11' at 4424' 4' at 4412' 17' at 4391' T D 127'
SH-32 4201' 25' at 4147' T D 80'
WW
SH-39
4314'
180'
North
Fork
SH-31 4277' 12' at 4245' 19' at 4184' T D 138'
South
Fork
15'
20'
SH-37 4318' 22' at 4280' T D 105'
Fourmile
Creek
WW
WW
SH-50
SH-7015
Vessels
SH-108
SH-735
BIG HORN CO.
ROSEBUD CO.

Project Chief - R E Matson
Geologists - L J Maki
- M R Garverich
- V. Hoare
Draftsman - E A Woods


N
T. 6 S.
T. 7 S.
CROW INDIAN RESERVATION
R. 39 E.
S.C.
K
SH-36
4285'
25' at 4182'
T.D. 130'
SH-35
4456'
11' at 4370'
T.D. 99'
SH-723
4592'
7' at 4476'
T.D. 220'
McD-16
Lost hole
McD-17
4040'
McD-15
McD-6
Lost hole
McD-10
McD-8
4030
McD-5
4060'
McD-3
McD-4
McD-11
3960
Stanolind Gov't
McD-2
4090
McD-1
4000'
McD-14
4080
McD-20
4100'
No Coal ?
T.D. 250'
McD-12
4080
SH-41
4471'
8' at 4379'
T.D. 135'
Guthrie
WW
Canyon
Creek
Bear Creek
Dry Creek
Indian
ROSEBUD
CREEK
SCREEN
SH-722
4493'
25' at 4388'
T.D. 240'
SH-721
4239'
22' at 4155'
54' at 3833'
T.D. 460'
Cabot
SH-38
4494'
11' at 4424'
4' at 4412'
17' at 4391'
T.D. 127'
SH-32
4201'
25' at 4147'
T.D. 80'
SH-39
4383'
5' at 4314'
T.D. 180'
WALL
ANDERSON
COAL
RED
BED
Vessels Helvey
SH-56
4482'
25' at 4411'
T.D. 150'
E-8-1
E-3
E-17-1
E-16-2
E-18-1c
E-16-1c
North
South
Fork
SH-37
4318'
22' at 4280'
T.D. 105'
15'
20'
25'
U
D
SH-731
SH-55
SH-736
4253'
26' at 4192'
43' at 4149'
T.D. 186'
SH-731 A
4357'
9' at 4296'
T.D. 80'
SH-107
4190'
17' at 4166'
25' at 4110'
28' at 4049'
T.D. 180'
SH-7012
E-35-13
Lost
Rock
Creek
SH-732
4308'
Clinker
T.D. 546'

Base map from U.S.G.S advance topographic quadrangle maps, Kirby, Taintor Desert, Half Moon Hill, and Tongue River Dam

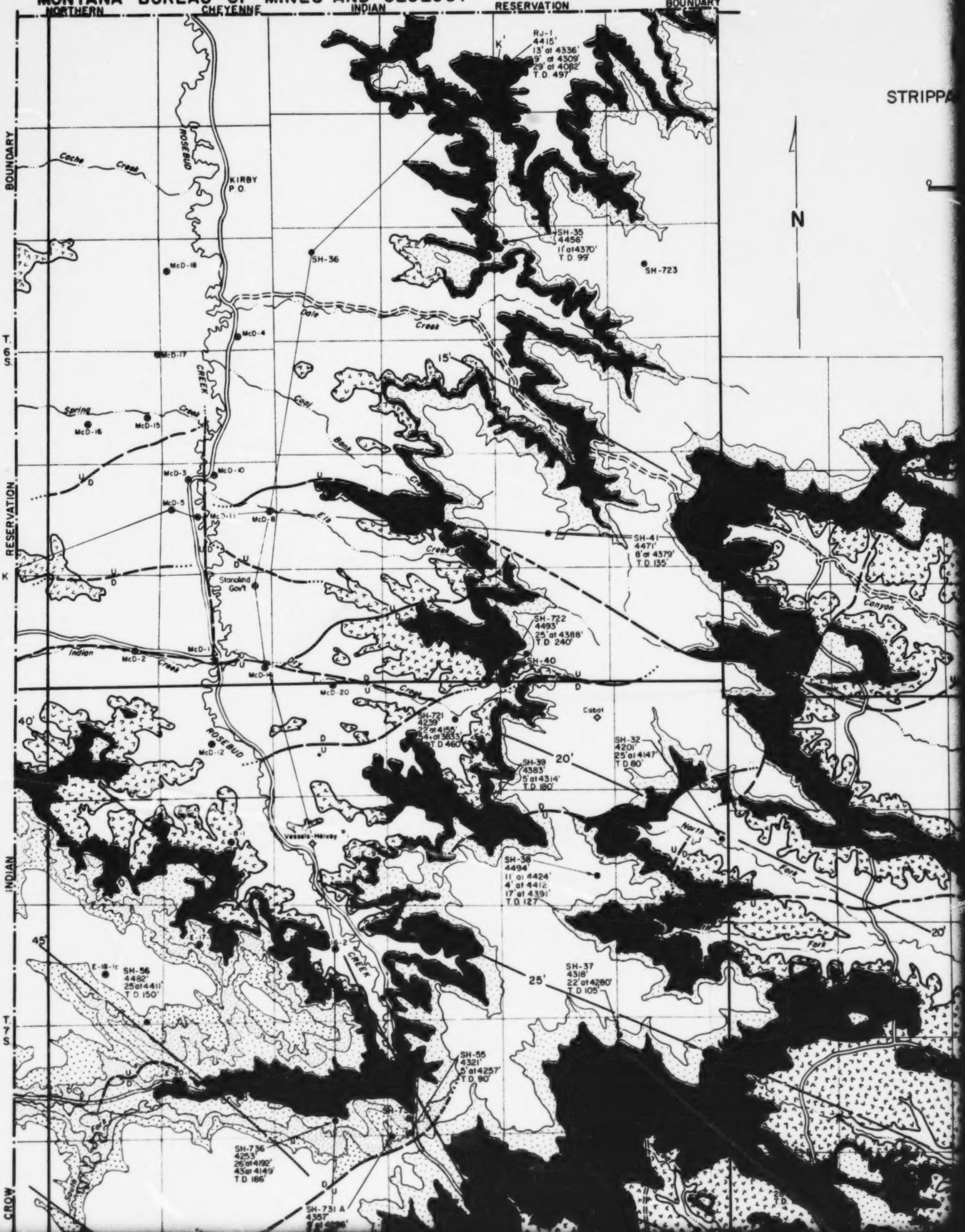
C


SCALE
0 1/2 1 2 3 MILES
DATUM IS MEAN SEA LEVEL
N
EXPLANATION
Outcrop of coal beds, dashed where inferred.
Clinker
Anderson coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
Wall coal bed (average thickness 45')
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
200'-250' " "
SH-38 M.B.M.G. drill hole hole designation
4494' altitude at top of collar
17' at 4391' altitude at top of 17' of coal
T.D. 127' total depth of drill hole
E-8-1 Private drill hole
Cabot Oil well drill hole
WW Water well drill hole
20' Isopach of Anderson coal bed
U D Fault, dashed and dotted where inferred
K B Line of cross section (plate 33)
Project Chief - R. E. Matson
Geologists - L. J. Maki
- M. R. Garverich
- V. Heare
Draftsman - E. A. Woods
SH-35 4456' 11' at 4370' T.D. 99'
SH-723 4592' 7' at 4476' T.D. 220'
SH-41 4471' 8' at 4379' T.D. 135'
Guthrie
WW
B
Canyon
Creek
SH-38 4494' 11' at 4424' 4' at 4412' 17' at 4391' T.D. 127'
SH-32 4201' 25' at 4147' T.D. 80'
Cabot
SH-50
North
Fork
South
Fork
15'
SH-31 4277' 12' at 4245' 19' at 4184' T.D. 138'
Fourmile
Creek
BIG HORN CO.
ROSEBUD CO.
SH-37 4318' 22' at 4280' T.D. 105'
20'
SH-7015
Vessels 3
SH-108
SH-735
SH-107 4198' 17' at 4166' 25' at 4110' 28' at 4049' T.D. 180'
20'
SH-7012
E-35-15
25'
Rosa
Creek
Post
Creek
SH-7014
U D
R. 40 E.

D

72

MONTANA BUREAU OF MINES AND GEOLOGY


NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
CROW INDIAN RESERVATION BOUNDARY
STRIPPA
N
T. 6 S.
T. 7 S.
K
K'
KIRBY P.O.
ROSEBUD CREEK
Cache Creek
Dale Creek
Coal Bank Creek
Spring Creek
Elk Creek
Indian Creek
Dry Creek
North Fork
Fork
Canyon
RJ-1 4415' 13' at 4336' 9' at 4309' 29' at 4082' T.D. 497'
SH-35 4456' 11' at 4370' T.D. 99'
SH-36
SH-723
SH-41 4471' 8' at 4379' T.D. 135'
SH-722 4493' 25' at 4388' T.D. 240'
SH-40
SH-721 4279' 22' at 4155' 44' at 3833' T.D. 460'
Cabot
SH-32 4201' 25' at 4147' T.D. 80'
SH-39 4383' 5' at 4314' T.D. 180'
SH-38 4494' 11' at 4424' 4' at 4412' 17' at 4391' T.D. 127'
SH-37 4318' 22' at 4280' T.D. 105'
SH-56 4482' 25' at 4411' T.D. 150'
SH-55 4321' 5' at 4257' T.D. 90'
SH-736 4253' 26' at 4192' 43' at 4149' T.D. 186'
SH-731 A 4357'
SH-7
McD-18
McD-4
McD-17
McD-16
McD-15
McD-3
McD-10
McD-5
McD-11
McD-8
McD-1
McD-2
McD-14
McD-20
McD-12
Stanolind Gov't
Vessels-Heivey
E-8
E-17
E-18
E-20
15'
20'
25'
40'
45'
U
D

BULLETIN 91 PLATE 5B

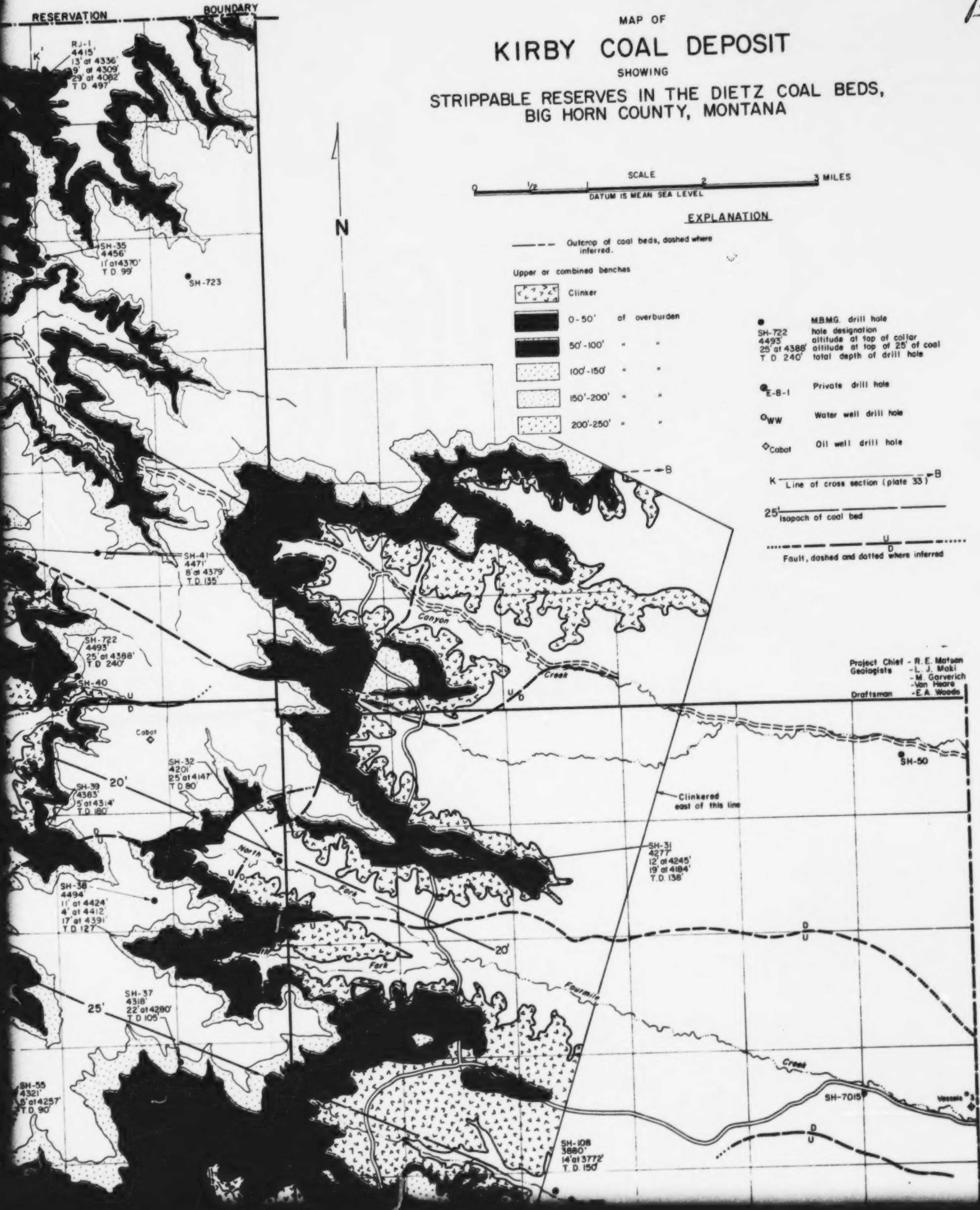
B

MAP OF

KIRBY COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE DIETZ COAL BEDS, BIG HORN COUNTY, MONTANA


N
SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL
RESERVATION
BOUNDARY
K'
RJ-1
4415'
13' at 4336'
9' at 4309'
29' at 4082'
T D 497'
SH-35
4456'
11' at 4370'
T D 99'
SH-723
SH-41
4471'
8' at 4379'
T.D. 135'
SH-722
4493'
25' at 4388'
T.D. 240'
SH-40
U
D
Cabot
SH-32
4201'
25' at 4147'
T.D. 80'
SH-39
4383'
5' at 4314'
T.D. 180'
20'
SH-38
4494
11' at 4424'
4' at 4412
17' at 4391'
T.D. 127'
North
Fork
Canyon
Creek
B
Clinkered east of this line
SH-31
4277'
12' at 4245'
19' at 4184'
T.D. 138'
SH-50
20'
Fork
Fourmile
Creek
25'
SH-37
4318'
22' at 4280'
T.D. 105'
SH-55
4321'
6' at 4257'
T.D. 90'
SH-108
3880'
14' at 3772'
T. D. 150'
SH-7015
Vessels 3

EXPLANATION

- Outcrop of coal beds, dashed where inferred.

Upper or combined benches

- Clinker
- 0-50' of overburden
- 50'-100' " "
- 100'-150' " "
- 150'-200' " "
- 200'-250' " "

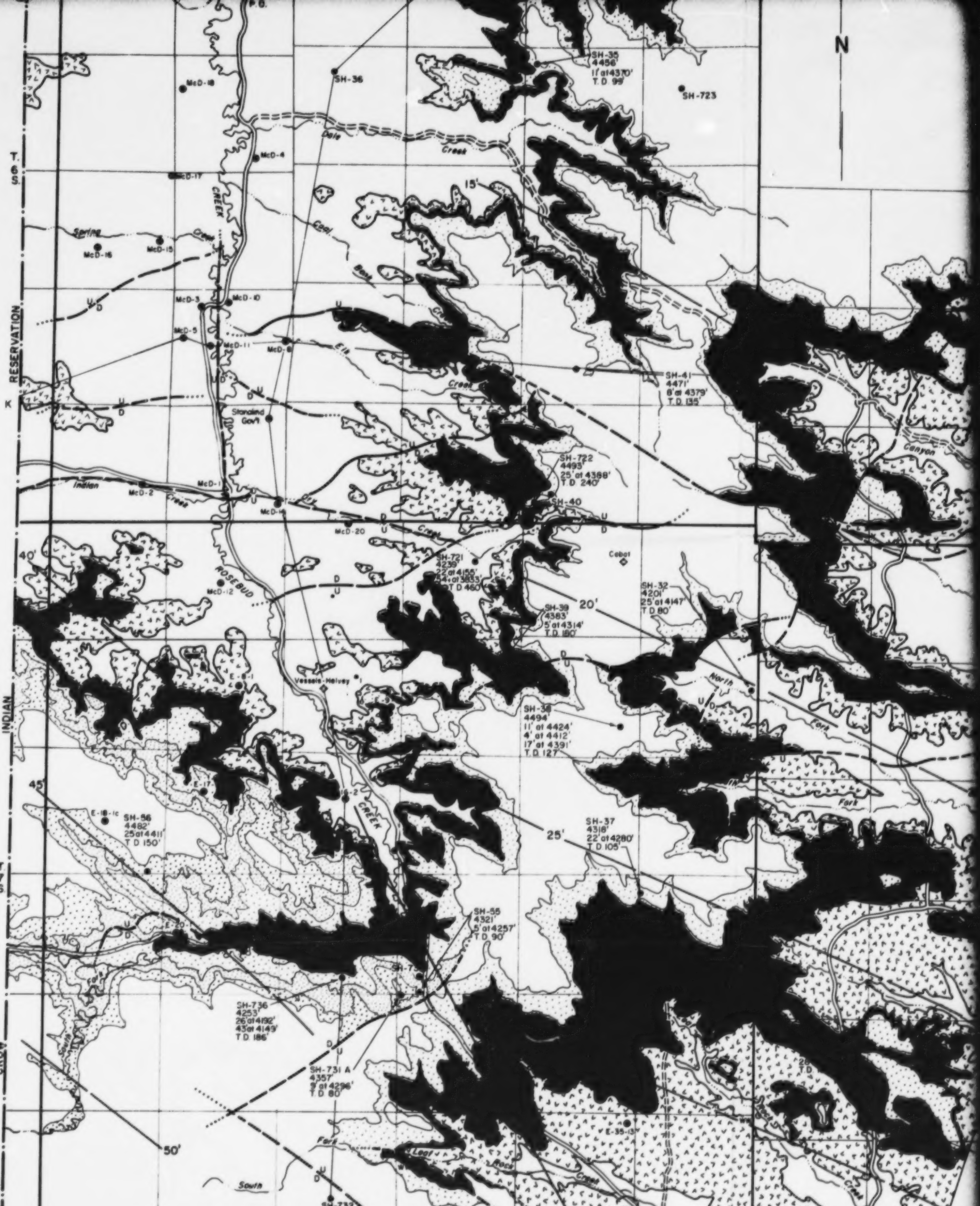
●	M.B.M.G. drill hole
SH-722	hole designation
4493'	altitude at top of collar
25' at 4388'	altitude at top of 25' of coal
T D 240'	total depth of drill hole
● E-8-1	Private drill hole
○ WW	Water well drill hole
◇ Cabot	Oil well drill hole

K — B Line of cross section (plate 33)

25' Isopach of coal bed

U/D Fault, dashed and dotted where inferred

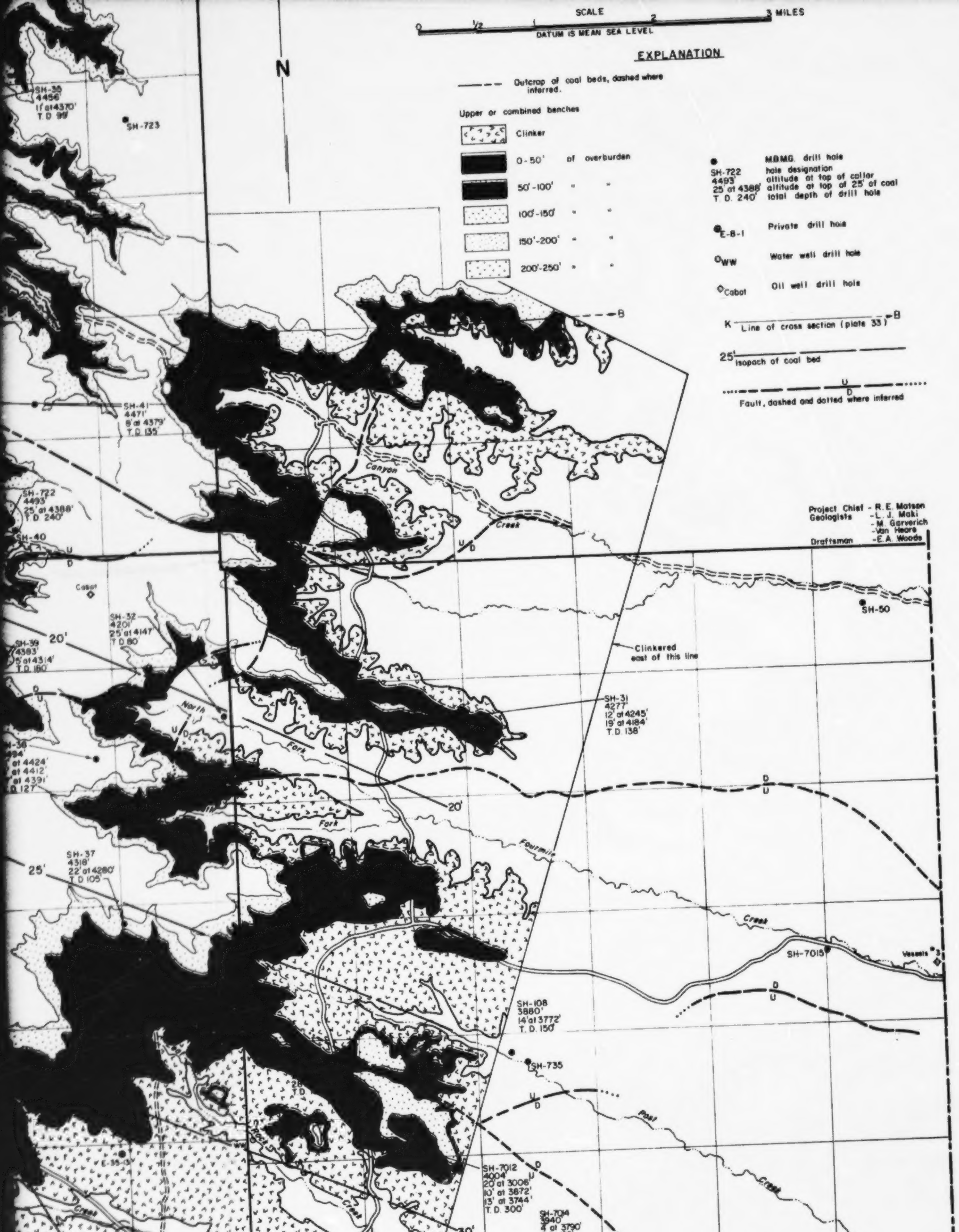
Project Chief - R. E. Matson
Geologists - L. J. Maki
- M. Garverich
- Van Haare
Draftsman - E. A. Woods


N
SH-35
4456'
11' at 4370'
T.D. 95'
SH-36
SH-723
McD-18
Dale
Creek
McD-4
T. 6 S.
McD-17
CREEK
15'
Coal
Spring
Creek
McD-16
McD-15
Bear
RESERVATION
McD-3
McD-10
McD-5
McD-11
McD-8
Elk
Creek
SH-41
4471'
8' at 4379'
T.D. 135'
K
Stanolind Gov't
SH-722
4493'
25' at 4368'
T.D. 240'
Canyon
Indian
McD-2
Creek
McD-1
McD-14
Dry
SH-40
McD-20
Creek
Cabot
40'
SH-721
4239'
22' at 4155'
54' at 3833'
T.D. 460'
ROSEBUD
McD-12
SH-32
4201'
25' at 4147'
T.D. 80'
20'
SH-39
4383'
5' at 4314'
T.D. 190'
North
INDIAN
Vessels-Helvey
E-8-1
SH-38
4494'
11' at 4424'
4' at 4412'
17' at 4391'
T.D. 127'
Fork
E-17
45'
E-18-1c
SH-56
4482'
25' at 4411'
T.D. 150'
CREEK
Fork
25'
SH-37
4316'
22' at 4280'
T.D. 105'
T. 7 S.
SH-55
4321'
5' at 4257'
T.D. 90'
E-20
SH-736
4253'
26' at 4192'
43' at 4149'
T.D. 186'
CROW
SH-731 A
4357'
3' at 4296'
T.D. 80'
50'
Fork
Leaf
Rock
Creek
E-35-13
South
SH-732
WW
Creek
30'
SC.
R. 39 E.
U
D
Combined
Split

Base map from U.S.G.S advance topographic quadrangle maps:
Kirby, Tanktar Desert, Half Moon Hill, and Tongue River Dam

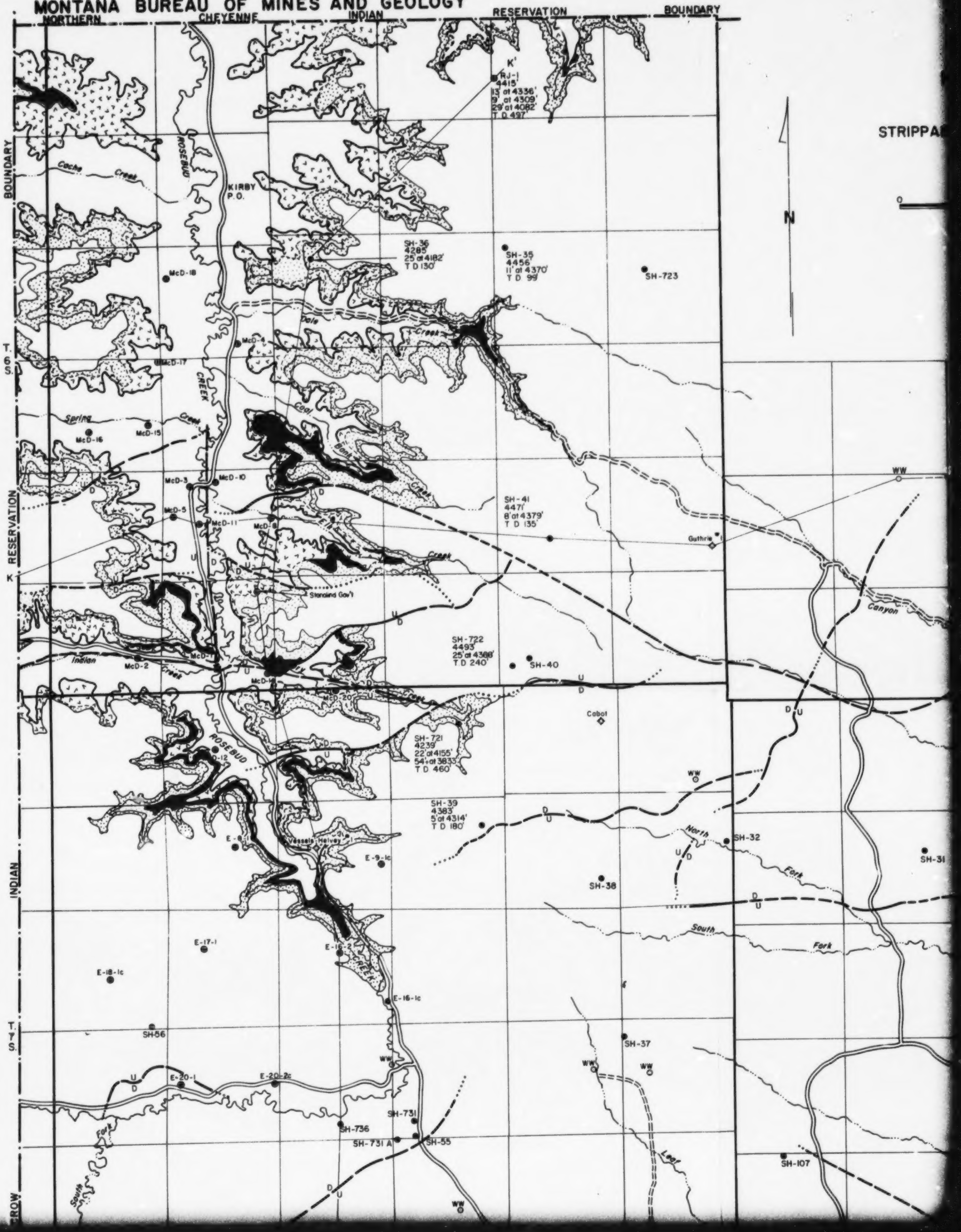
Combined — Split
Approximate location of split in coal bed

c


SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL
EXPLANATION
Outcrop of coal beds, dashed where inferred.
Upper or combined benches
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
200'-250' " "
MBMG. drill hole
SH-722 hole designation
4493' altitude at top of collar
25' at 4388' altitude at top of 25' of coal
T.D. 240' total depth of drill hole
E-8-1 Private drill hole
WW Water well drill hole
Cabot Oil well drill hole
K Line of cross section (plate 33) B
25' Isopach of coal bed
U D
Fault, dashed and dotted where inferred
Project Chief - R.E. Matson
Geologists - L. J. Maki
- M. Garverich
- Van Heare
Draftsman - E.A. Woods
N
SH-35
4456'
11' at 4370'
T.D. 99'
SH-723
SH-41
4471'
8' at 4379'
T.D. 135'
SH-722
4493'
25' at 4388'
T.D. 240'
SH-40
Cabot
SH-32
4201'
25' at 4147'
T.D. 80
SH-39
4383'
5' at 4314'
T.D. 180'
20'
SH-38
at 4424'
at 4412'
at 4391'
T.D. 127'
SH-37
4318'
22' at 4280'
T.D. 105'
25'
E-35-13
WW
Combined — Split
Approximate location of split in coal bed
B
Canyon
Creek
North
Fork
Fork
Fourmile
Creek
Clinkered east of this line
SH-31
4277'
12' at 4245'
19' at 4184'
T.D. 138'
20'
SH-50
SH-7015
Vessels 3
SH-108
3880'
14' at 3772'
T.D. 150'
SH-735
Post
Creek
Creek
Creek
SH-7012
4004'
20' at 3006'
10' at 3872'
13' at 3744'
T.D. 300'
SH-7014
3940'
4' at 3790'
T.D. 188
30'
R. 40 E.

D

MONTANA BUREAU OF MINES AND GEOLOGY


NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
INDIAN RESERVATION BOUNDARY
CROW
STRIPPA
N
0
K'
RJ-1
4415'
13' at 4336'
9' at 4309'
29' at 4082'
T D 497'
ROSEBUD
Cache Creek
KIRBY P.O.
SH-36
4285'
25' at 4182'
T D 130'
SH-35
4456'
11' at 4370'
T D 99'
SH-723
McD-18
Dale Creek
McD-4
T. 6 S.
McD-17
CREEK
Coal Bank Creek
Spring Creek
McD-16
McD-15
McD-3
McD-10
D
U
McD-5
McD-11
McD-8
SH-41
4471'
8' at 4379'
T D 135'
Guthrie
WW
Creek
K
Stoneland Gov't
Canyon
SH-722
4493'
25' at 4388'
T D 240'
SH-40
Indian Creek
McD-2
McD-7
McD-14
McD-20
Cabot
SH-721
4239'
22' at 4155'
54+' at 3833'
T D 460'
ROSEBUD
D-12
SH-39
4383'
5' at 4314'
T D 180'
E-8
Vessels Helvey
E-9-1c
North Fork
SH-32
SH-38
SH-31
South Fork
E-17-1
E-16-2
CREEK
E-18-1c
E-16-1c
T. 7 S.
SH-56
SH-37
E-20-1
E-20-2c
SH-731
SH-736
SH-731 A
SH-55
Leaf
SH-107
South Fork

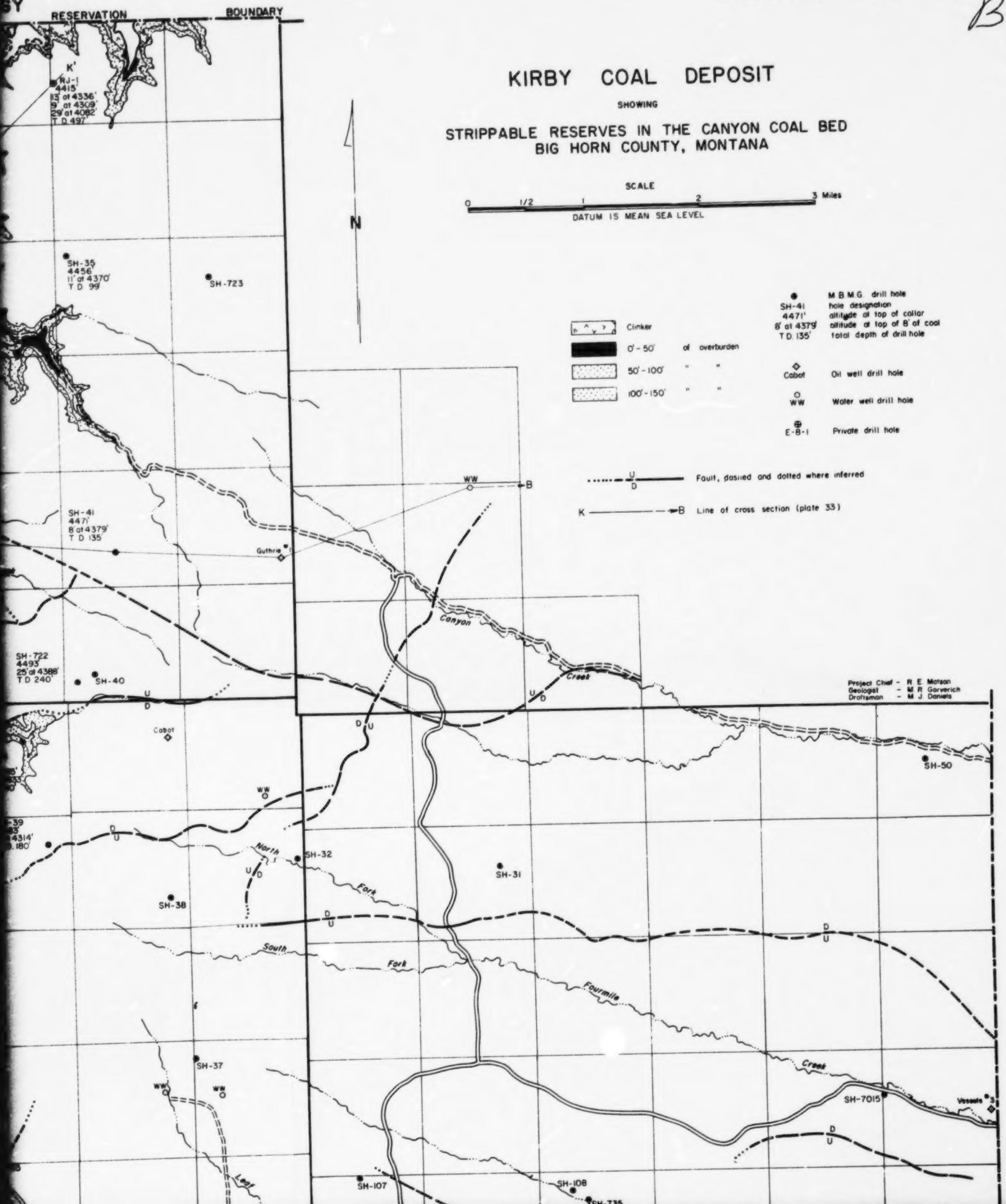
BULLETIN 91 PLATE 5C

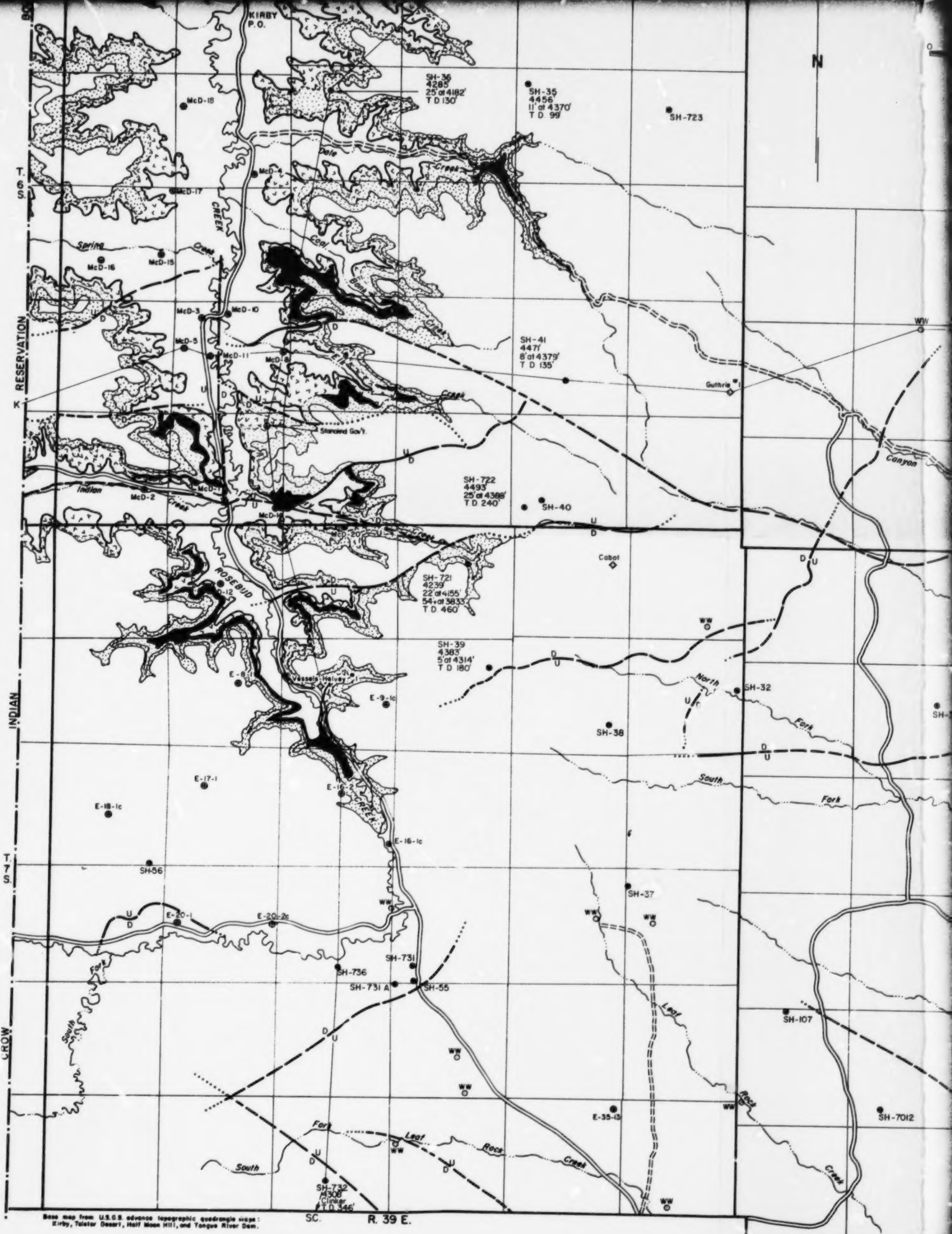
B

KIRBY COAL DEPOSIT

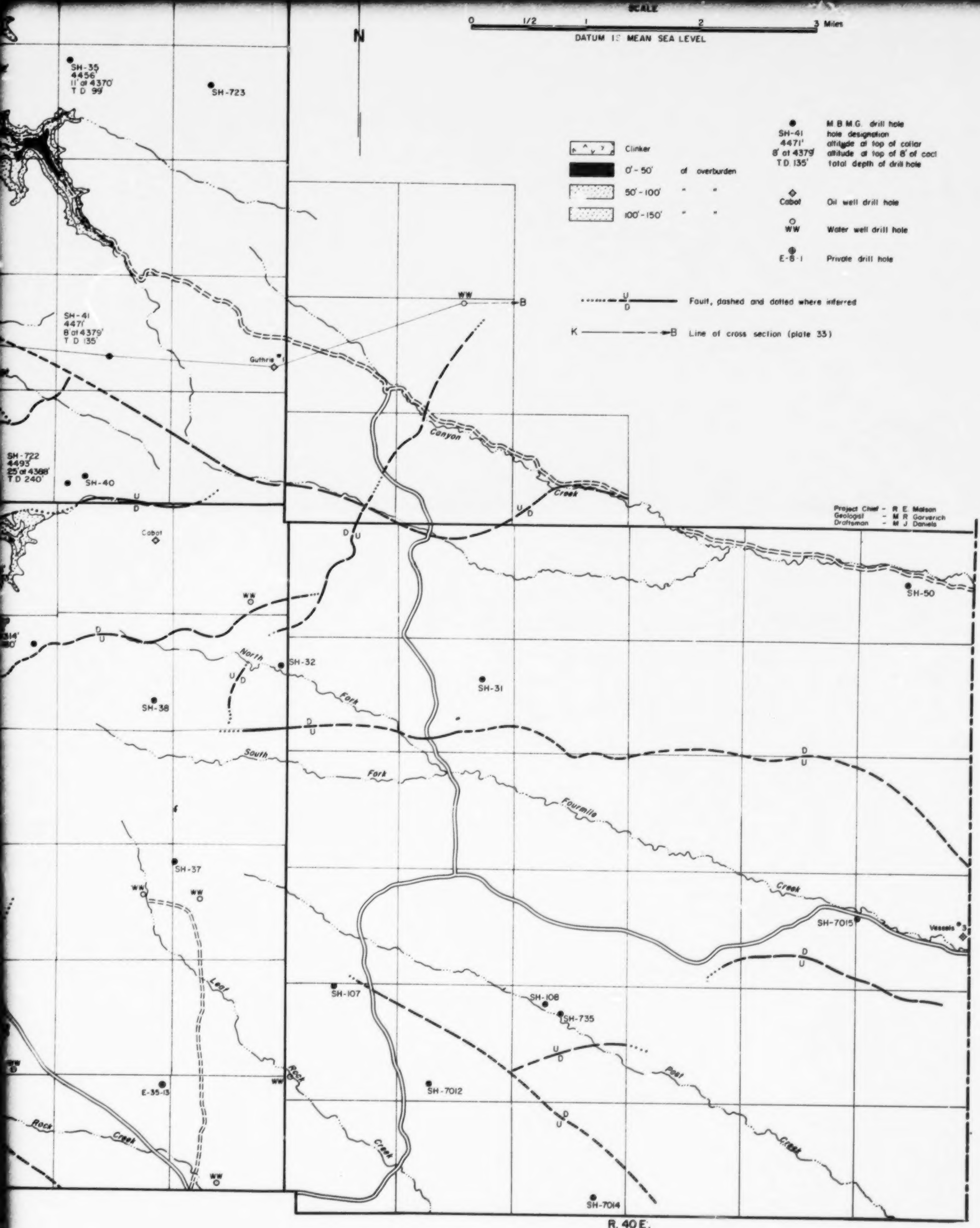
SHOWING

STRIPPABLE RESERVES IN THE CANYON COAL BED
BIG HORN COUNTY, MONTANA


SCALE
0
1/2
1
2
3 Miles
DATUM IS MEAN SEA LEVEL
N
Clinker
0'-50' of overburden
50'-100' " "
100'-150' " "
● M.B.M.G. drill hole
SH-41 hole designation
4471' altitude of top of collar
8' at 4379' altitude at top of 8' of coal
T.D. 135' total depth of drill hole
◇ Cabot Oil well drill hole
○ WW Water well drill hole
⊕ E-B-1 Private drill hole
U D Fault, dashed and dotted where inferred
K → B Line of cross section (plate 33)
Project Chief - R. E. Matson
Geologist - M. R. Garverich
Draftsman - M. J. Daniels
RESERVATION
BOUNDARY
K'
RJ-1
4415'
13' at 4336'
9' at 4309'
29' at 4082'
T.D. 497'
SH-35
4456'
11' at 4370'
T.D. 99'
SH-723
SH-41
4471'
8' at 4379'
T.D. 135'
Guthrie 1
WW
B
Canyon
Creek
SH-722
4493'
25' at 4388'
T.D. 240'
SH-40
Cabot
WW
SH-50
North
Fork
SH-32
SH-31
SH-38
South
Fork
Fourmile
Creek
SH-37
WW
WW
SH-7015
Vessels 3
Leaf
SH-107
SH-108
SH-735
U
D


KIRBY P.O.
N
T. 6 S.
T. 7 S.
CROW INDIAN RESERVATION
K
SH-36
4285
25' at 4182'
T D 130'
SH-35
4456
11' at 4370'
T D. 99'
SH-723
McD-18
McD-4
McD-17
McD-16
McD-15
McD-3
McD-10
McD-5
McD-11
McD-8
McD-2
McD-1
McD-20
McD-12
Dale Creek
Coal Bank Creek
Elk Creek
Spring Creek
Indian Creek
Stanolind Gov't.
SH-41
4471'
8' at 4379'
T D 135'
Guthrie 1
WW
Canyon
SH-722
4493'
25' at 4388'
T D 240'
SH-40
Cabot
SH-721
4239'
22' at 4155'
54+ at 3833'
T D 460'
SH-39
4383'
5' at 4314'
T D 180'
ROSEBUD CREEK
Vessels Helvey 1
E-8
E-9-1c
SH-32
North Fork
SH-38
South Fork
E-17-1
E-16-2
E-18-1c
E-16-1c
SH-56
SH-37
E-20-1
E-20-2c
SH-731
SH-736
SH-731 A
SH-55
SH-107
Leaf Rock Creek
E-35-13
SH-7012
South Fork Leaf Rock Creek
SH-732
4308'
Clinker
T D 346'
SC.
R. 39 E.
U
D

Base map from U.S.G.S. advance topographic quadrangle maps: Kirby, Tolstar Desert, Half Moon Hill, and Tongue River Dam.


SCALE
0
1/2
1
2
3 Miles
DATUM IS MEAN SEA LEVEL
N
Clinker
0'-50' of overburden
50'-100' " "
100'-150' " "
SH-41 M.B.M.G. drill hole
hole designation
4471' altitude at top of collar
8' at 4379' altitude at top of 8' of coal
T.D. 135' total depth of drill hole
Cabot Oil well drill hole
WW Water well drill hole
E-8-1 Private drill hole
Fault, dashed and dotted where inferred
K B Line of cross section (plate 33)
Project Chief - R E Matson
Geologist - M R Gorverich
Draftsman - M J Daniels
SH-35
4456'
11' at 4370'
T.D. 99'
SH-723
SH-41
4471'
8' at 4379'
T.D. 135'
Guthrie
WW
B
Canyon
Creek
SH-722
4493'
25' at 4368'
T.D. 240'
SH-40
U
D
Cabot
WW
SH-50
North
Fork
SH-32
SH-31
SH-38
South
Fork
Fourmile
Creek
SH-37
WW
SH-7015
Vessels 3
SH-107
SH-108
SH-735
Leaf
Rock
Post
Creek
SH-7012
E-35-13
Rock
Creek
SH-7014
R. 40 E.

D

A

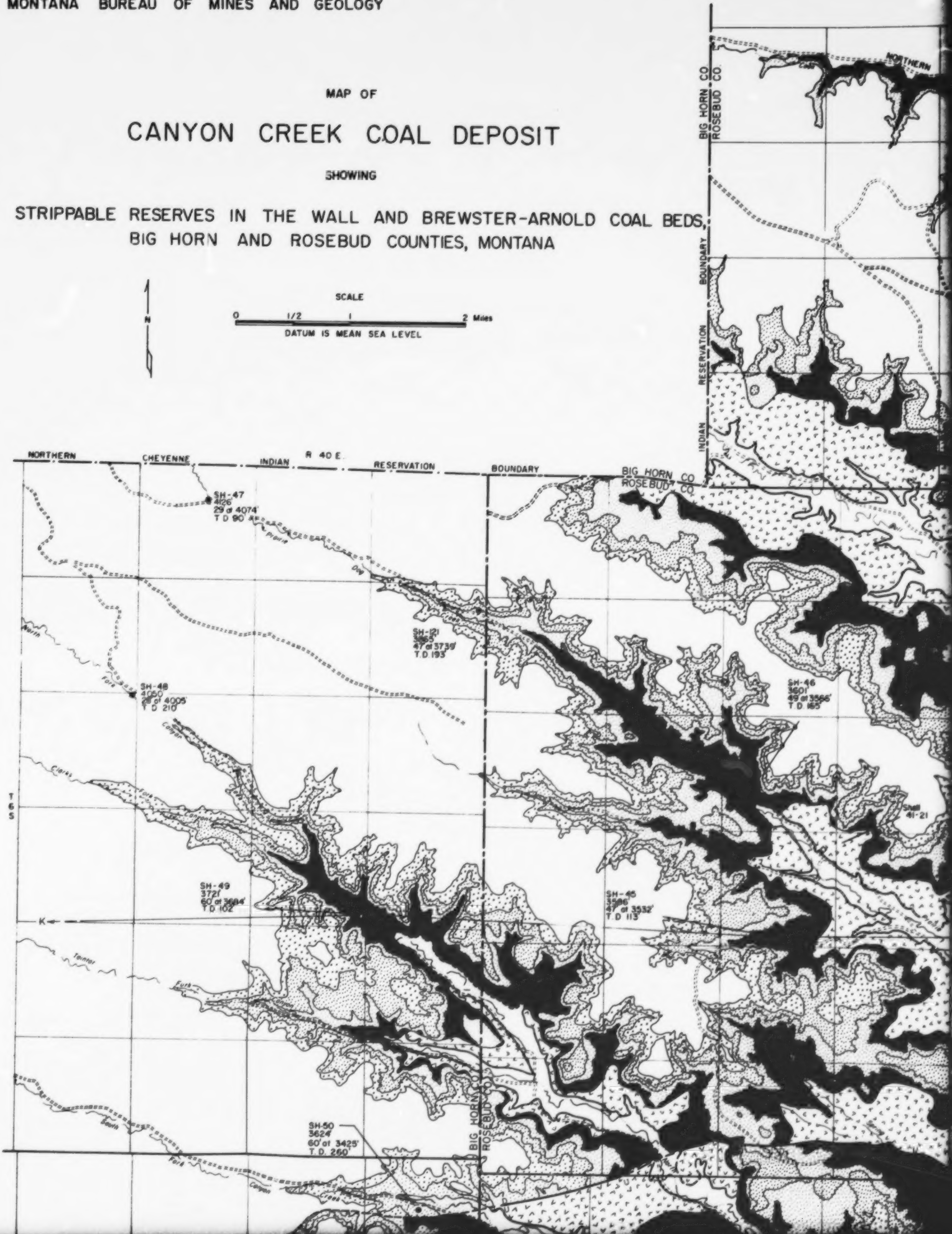
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

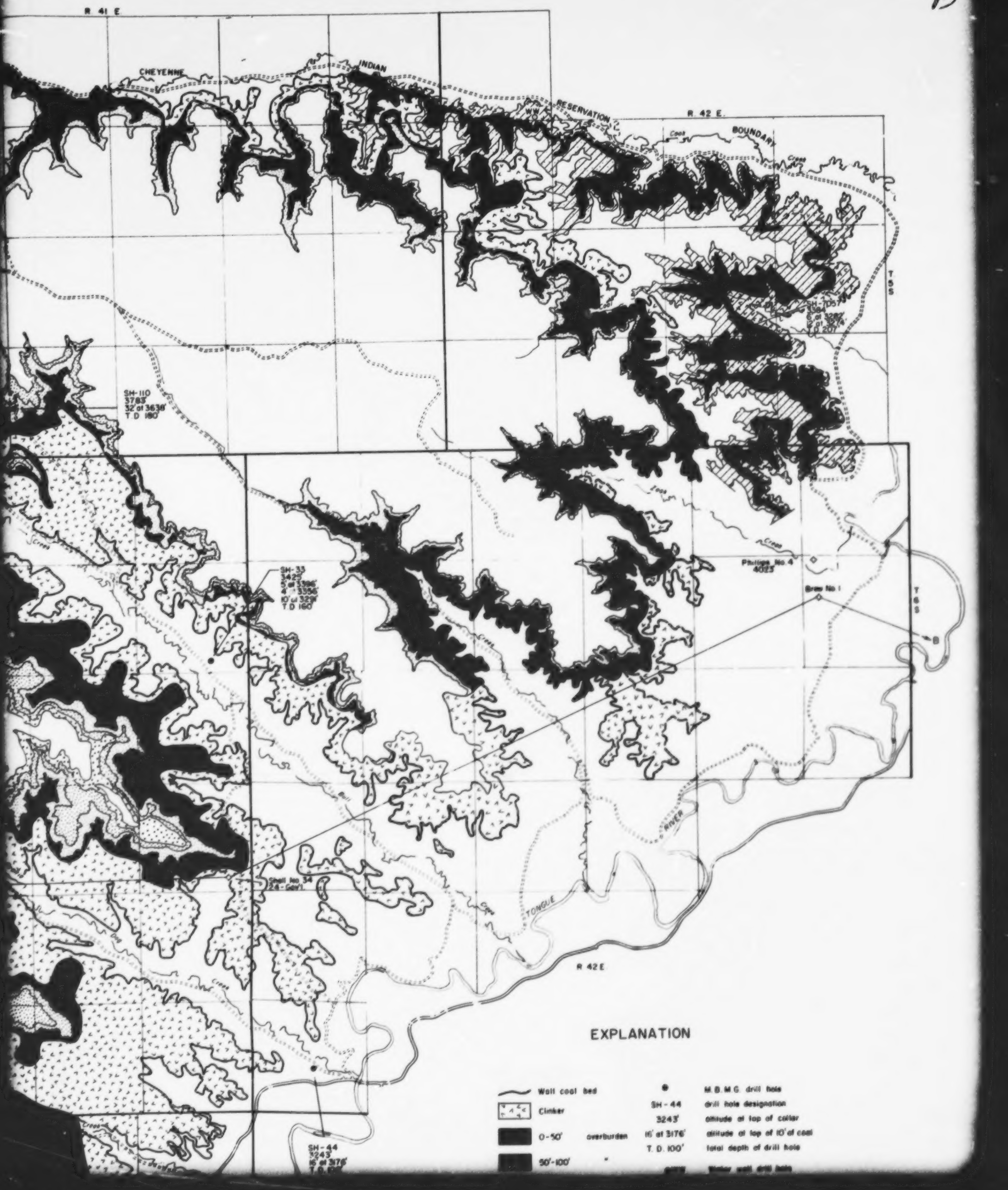
CANYON CREEK COAL DEPOSIT

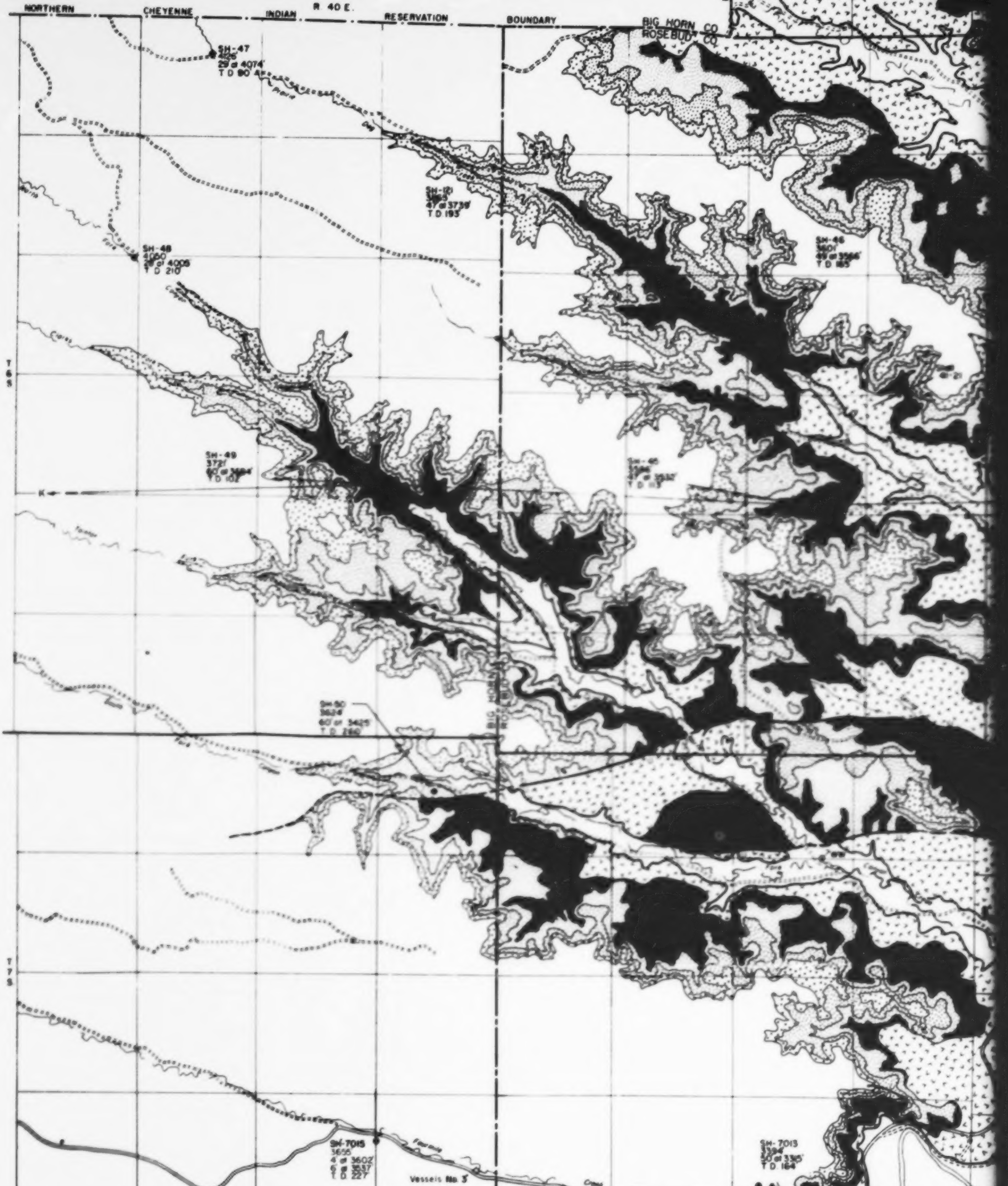
SHOWING

STRIPPABLE RESERVES IN THE WALL AND BREWSTER-ARNOLD COAL BEDS,
BIG HORN AND ROSEBUD COUNTIES, MONTANA


N
SCALE
0
1/2
1
2 Miles
DATUM IS MEAN SEA LEVEL
NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
R 40 E.
BIG HORN CO.
ROSEBUD CO.
NORTHERN
INDIAN RESERVATION BOUNDARY
BIG HORN CO
ROSEBUD CO.
SH-47
4126'
29' at 4074'
T D 90'
Prairie
Dog
SH-121
3965'
47' at 3739'
T.D 193'
SH-48
4050'
26' at 4005'
T D 210'
Canyon
SH-46
3601'
49' at 3566'
T.D 165'
Shell
41-21
T 6 S
SH-49
3721'
60' at 3684'
T.D 102'
SH-45
3586'
47' at 3532'
T.D 113'
K
Tainter
Fork
South
Fork
Canyon
SH-50
3624'
60' at 3425'
T.D. 260'
BIG HORN CO.
ROSEBUD CO.

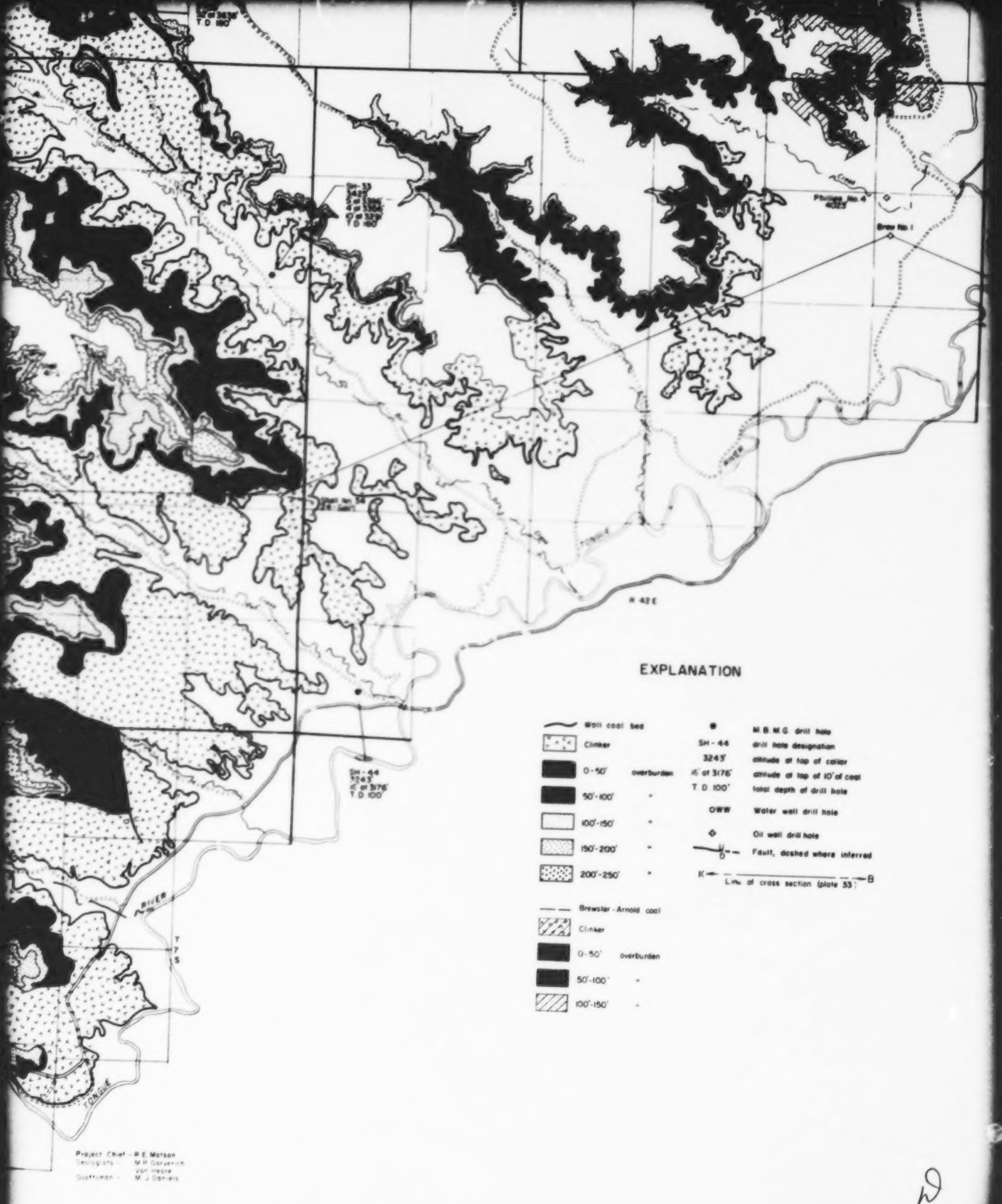
BULLETIN 91 PLATE 6 B


R 41 E
R 42 E.
R 42 E
T 5 S
T 6 S
CHEYENNE INDIAN RESERVATION BOUNDARY
Coal Creek
Creek
TONGUE RIVER
SH-110
3783'
32' at 3638'
T.D. 160'
SH-33
3425'
5' at 3396'
4' at 3356'
10' at 3297'
T.D. 160'
SH-705
6' at
12' at
T.D. 207
Phillips No. 4
4025'
Brew No. 1
B
Shell No. 34
SH-44
3243'
16' at 3176'
T.D. 100'
EXPLANATION
Wall coal bed
Clinker
0-50' overburden
50'-100' "
M.B.M.G. drill hole
SH-44 drill hole designation
3243' altitude at top of collar
16' at 3176' altitude at top of 16' of coal
T.D. 100' total depth of drill hole


NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
R 40 E.
BIG HORN CO
ROSEBUD CO
SH-47
4125'
29 at 4074'
T D 90
SH-48
4060
29 at 4005
T D 210
SH-121
3765'
47 at 3739'
T D 193
SH-46
3601'
69 at 3566'
T D 185
SH-49
3721'
60 at 3664'
T D 102
SH-45
3596'
47 at 3532'
T D 113
T 6 S
K
SH-50
3624
60 at 3425'
T D 260
T 7 S
SH-7015
3655
4 at 3602
6 at 3537
T D 227
Vessels No. 3
SH-7013
3394
50 at 3315'
T D 164
R 40 E.
R 41 E.

Base map from U.S.G.S. advance topographic quadrangle maps: [illegible], Birney, Birney SW, Tongue River Dam, Spring Gulch, Oldfield Creek, Coal Creek Butte.

C



SH-33
T.D. 100'
Phillips No. 4
4023'
Brew No. 1
RIVER
TONGUE
R 42 E
T
7
S
SH-44
3243'
16' at 3176'
T.D. 100'
EXPLANATION
Wall coal bed
Clinker
0-50' overburden
50'-100' "
100'-150' "
150'-200' "
200'-250' "
Brewster - Arnold coal
Clinker
0-50' overburden
50'-100' "
100'-150' "
M.B.M.G. drill hole
SH - 44 drill hole designation
3243' altitude at top of collar
16' at 3176' altitude at top of 10' of coal
T.D. 100' total depth of drill hole
OWW Water well drill hole
Oil well drill hole
U D Fault, dashed where inferred
K B Line of cross section (plate 33)

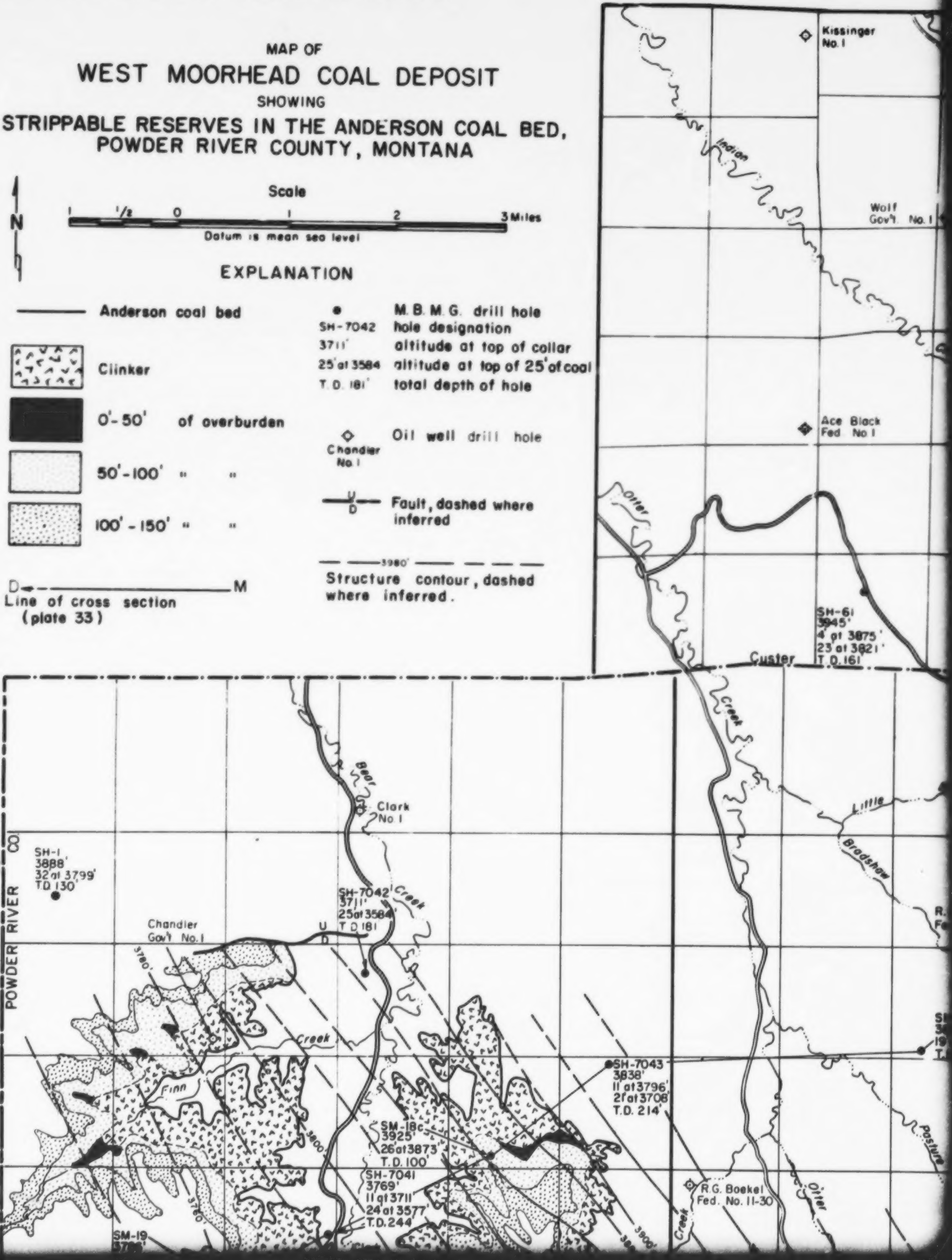
Project Chief - R.E. Matson
Geologists - M.R. Garverick
Van Hegre
Draftsman - M.J. Daniels

D

A

MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF
WEST MOORHEAD COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE ANDERSON COAL BED, POWDER RIVER COUNTY, MONTANA


N
Scale
1 1/2 0 1 2 3 Miles
Datum is mean sea level
Kissinger No. 1
Indian
Wolf Gov't. No. 1
Ace Black Fed. No 1
Otter
SH-61
3945'
4 at 3875'
23 at 3821'
T.D. 161
Custer
Creek
Bear
Clark No. 1
Little
Bradshaw
BIG HORN CO.
POWDER RIVER CO.
SH-1
3888'
32 at 3799'
T.D. 130'
SH-7042
3711'
25 at 3584'
T.D. 181'
Chandler Gov't No. 1
U
D
3780'
Creek
Finn
SH-7043
3838'
11 at 3796'
2 at 3708'
T.D. 214'
SM-18c
3925'
26 at 3873'
T.D. 100'
SH-7041
3769'
11 at 3711'
24 at 3577'
T.D. 244
3800
3760
SM-19
R.G. Boekel Fed. No. 11-30
Creek
Otter
Pasture
3900'

EXPLANATION

—— Anderson coal bed

Clinker

0'-50' of overburden

50'-100' " "

100'-150' " "

D◄- - - - - - - - M
Line of cross section
(plate 33)

● M. B. M. G. drill hole
SH-7042 hole designation
3711' altitude at top of collar
25' at 3584 altitude at top of 25' of coal
T. D. 181' total depth of hole

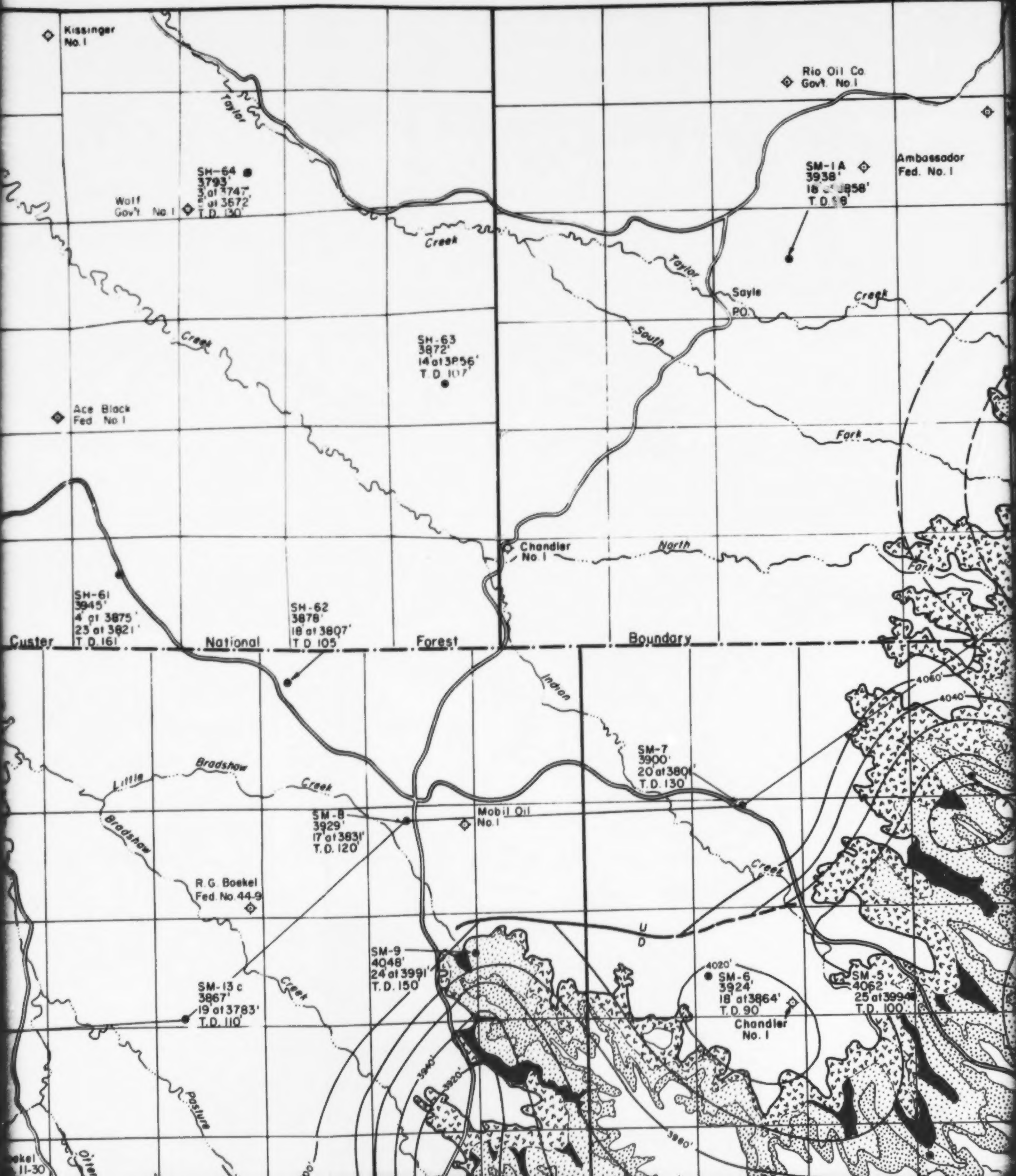
◇ Chandler No. 1 Oil well drill hole

U/D Fault, dashed where inferred

— — 3980' — — Structure contour, dashed where inferred.

B

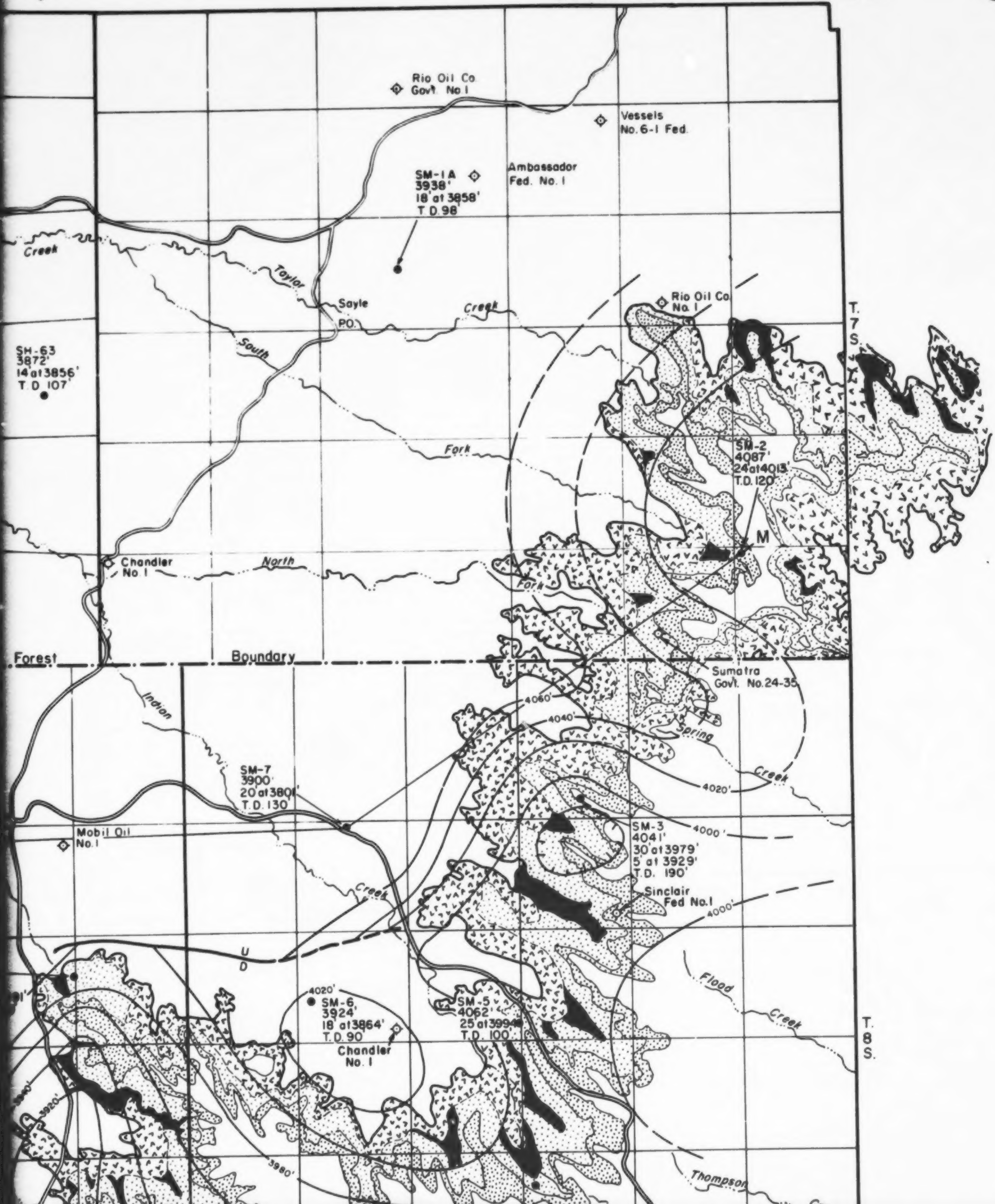
BULLE

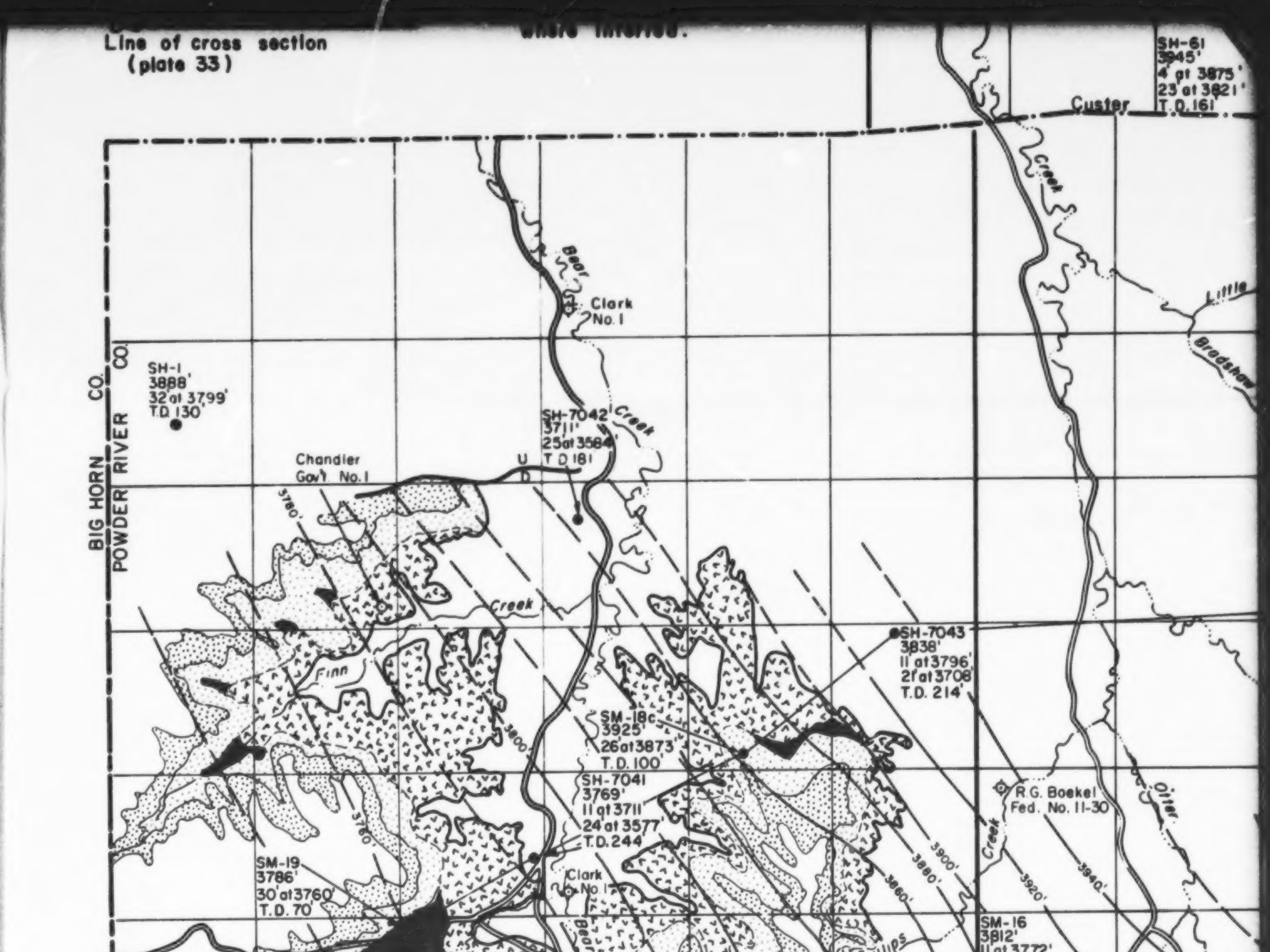

Kissinger No. 1
Taylor
SH-64 3793' 3 at 3747' 5 at 3672' T.D. 130'
Wolf Gov't. No. 1
Creek
Rio Oil Co. Gov't. No. 1
SM-1A 3938' 18 at 3858' T.D. 98'
Ambassador Fed. No. 1
Taylor
Sayle P.O.
Creek
South
Fork
Creek
SH-63 3872' 14 at 3856' T.D. 107'
Ace Black Fed No. 1
Chandler No. 1
North
Fork
SH-61 3945' 4 at 3875' 23 at 3821' T.D. 161'
SH-62 3878' 18 at 3807' T.D. 105'
Custer National Forest Boundary
Indian
4060'
4040'
SM-7 3900' 20 at 3801' T.D. 130'
Little Bradshaw Creek
Bradshaw
Creek
SM-8 3929' 17 at 3831' T.D. 120'
Mobil Oil No. 1
Creek
R.G. Boekel Fed. No. 44-9
U
D
SM-9 4048' 24 at 3991' T.D. 150'
4020'
SM-6 3924' 18 at 3864' T.D. 90'
Chandler No. 1
SM-5 4062' 25 at 3994' T.D. 100'
SM-13 c 3867' 19 at 3783' T.D. 110'
Creek
3940'
3920'
3960'
Pasture
Boekel 11-30
Otter

B

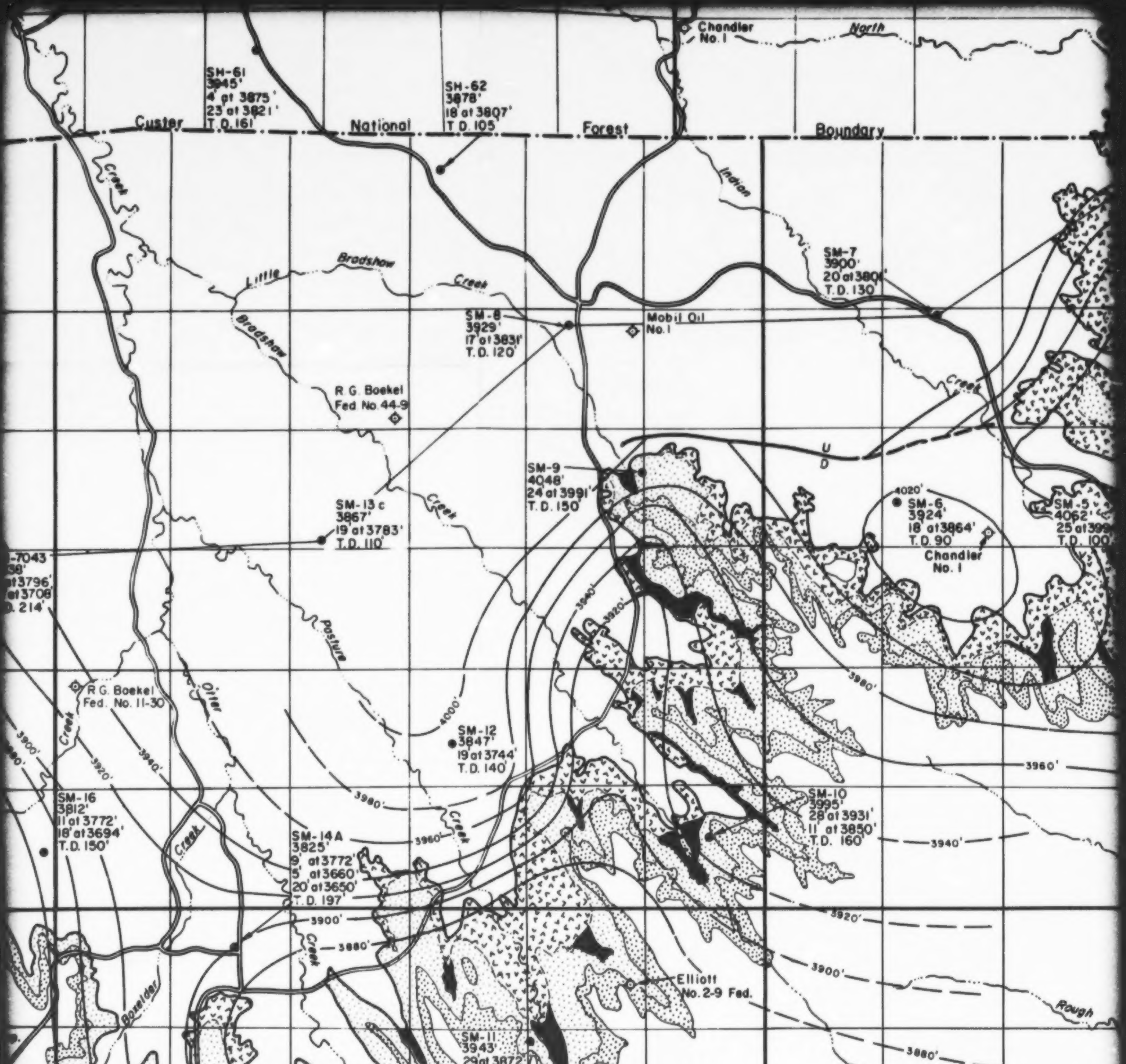
BULLETIN 91 PLATE 10 A

C

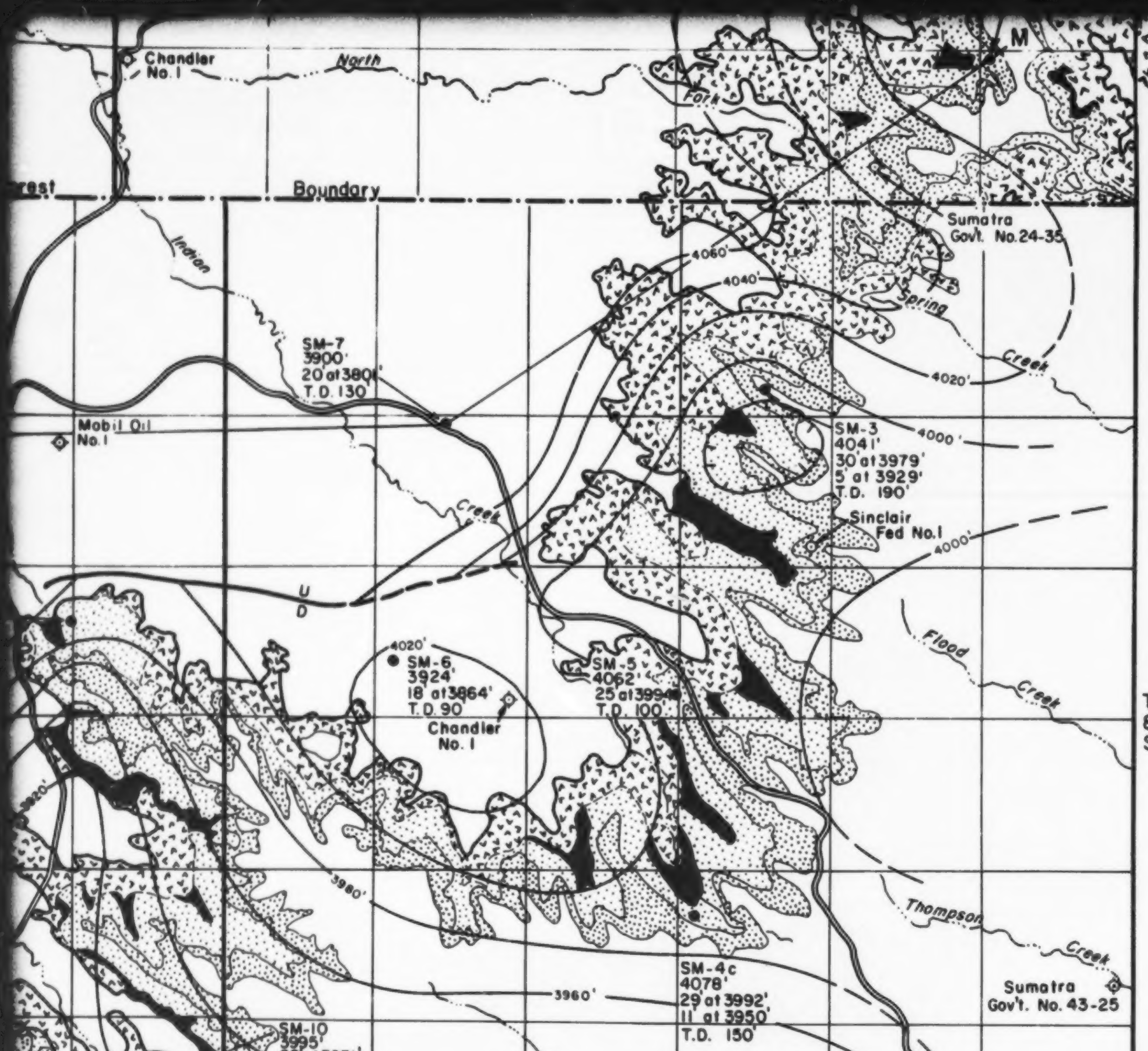

Rio Oil Co.
Gov't. No. 1
Vessels
No. 6-1 Fed.
SM-1A
3938'
18' at 3858'
T.D. 98'
Ambassador
Fed. No. 1
Creek
Taylor
Sayle
P.O.
Creek
Rio Oil Co.
No. 1
T.
7
S.
SH-63
3872'
14' at 3856'
T.D. 107'
South
Fork
SM-2
4087'
24' at 4013'
T.D. 120'
M
Chandler
No. 1
North
Fork
Forest
Boundary
Sumatra
Gov't. No. 24-35
Indian
4060'
4040'
Spring
Creek
4020'
SM-7
3900'
20' at 3801'
T.D. 130'
Mobil Oil
No. 1
4000'
SM-3
4041'
30' at 3979'
5' at 3929'
T.D. 190'
Creek
Sinclair
Fed No. 1
4000'
U
D
Flood
Creek
4020'
SM-6
3924'
18' at 3864'
T.D. 90'
Chandler
No. 1
SM-5
4062'
25' at 3994'
T.D. 100'
T.
8
S.
3920'
3980'
Thompson


Line of cross section
(plate 33)
where inferred.
SH-61
3945'
4 at 3875'
23 at 3821'
T.D. 161
Custer
Creek
Little
Bradshaw
BIG HORN CO.
POWDER RIVER CO.
SH-1
3888'
32 at 3799'
T.D. 130
Clark
No. 1
Bear
Creek
SH-7042
3711'
25 at 3584'
T.D. 181
U
D
Chandler
Gov't No. 1
3780'
Creek
Finn
SH-7043
3838'
11 at 3796'
21 at 3708'
T.D. 214'
SM-18c
3925'
26 at 3873'
T.D. 100'
3800
SH-7041
3769'
11 at 3711'
24 at 3577
T.D. 244
R.G. Boekel
Fed. No. 11-30
Otter
Creek
3900'
3880'
3860'
3920'
3940'
SM-19
3786'
30 at 3760'
T.D. 70'
3780
Clark
No. 1
Bear
Phillips
SM-16
3812'
11 at 3772'
18 at 3694'
T.D. 150'
Creek
3840'
3820'
D
True-Champlin
Fed. No. 11-6
Vance
Boxelder
Gulf Oil Corp.
3740'
SM-17
3820'
19 at 3777'
T.D. 100'
Creek
3760'
3780'
Fork
Creek
True
Oil Co.
R. 45 E.

Base map from 1966 U.S.G.S. open-file rept. by R.P. Bryson and N.W. Bass on the Moorhead coal field. (scale 1" = 1 mile)


Chandler No. 1
North
SH-61
3945'
4' at 3875'
23' at 3821'
T.D. 161'
SH-62
3878'
18' at 3807'
T.D. 105'
Custer National Forest Boundary
Creek
Indian
Little Bradshaw Creek
Bradshaw
SM-7
3900'
20 at 3800'
T.D. 130'
SM-8
3929'
17 at 3831'
T.D. 120'
Mobil Oil No. 1
R. G. Boekel Fed. No. 44-9
Creek
U
D
SM-9
4048'
24 at 3991'
T.D. 150'
4020'
SM-6
3924'
18 at 3864'
T.D. 90
Chandler No. 1
SM-5
4062'
25 at 399
T.D. 100
SM-13 c
3867'
19 at 3783'
T.D. 110'
-7043
38'
at 3796'
at 3708
D. 214'
Creek
Pasture
3940'
3920'
3980'
R. G. Boekel Fed. No. 11-30
Otter
4000'
SM-12
3847'
19 at 3744'
T.D. 140'
3900'
3880'
3920'
3940'
3960'
3960'
SM-16
3812'
11 at 3772'
18' at 3694'
T.D. 150'
Creek
SM-10
3995'
28 at 3931'
11 at 3850'
T.D. 160'
3940'
SM-14A
3825'
9' at 3772'
5' at 3660'
20' at 3650'
T.D. 197'
Creek
3900'
3880'
3920'
3900'
Elliott No. 2-9 Fed.
Rough
Boxelder
SM-11
3943'
29 at 3872'
11 at 3797'
T.D. 159'
3880'
SM-15c
3953'
14 at 3889'
6' at 3849'
T.D. 150'
Westrans No 14-11
True Oil Co.
R. 46 E.
R. 4

6


Chandler No. 1
North Fork
M
Crest
Boundary
Indian
Sumatra Gov't. No. 24-35
Spring Creek
4060'
4040'
4020'
4000'
SM-7 3900' 20 at 3801' T.D. 130
Mobil Oil No. 1
Creek
SM-3 4041' 30 at 3979' 5 at 3929' T.D. 190'
Sinclair Fed No. 1
4000'
U
D
4020'
SM-6 3924' 18 at 3864' T.D. 90
Chandler No. 1
SM-5 4062' 25 at 3994' T.D. 100
Flood Creek
T. 8 S.
3920'
3980'
Thompson Creek
SM-4c 4078' 29 at 3992' 11 at 3950' T.D. 150'
Sumatra Gov't. No. 43-25
3960'
SM-10 3995' 28 at 3931' 11 at 3850' T.D. 160'
3940'
Trail
Chandler No. 1
3920'
3900'
Elliott No. 2-9 Fed.
Rough Creek
Creek
3880'
T. 9 S.
Harrison Fed. No. 1-13
R. 47 E.

Project Chief and Geologist — R. E. Matson
Draftsman — E. A. Woods

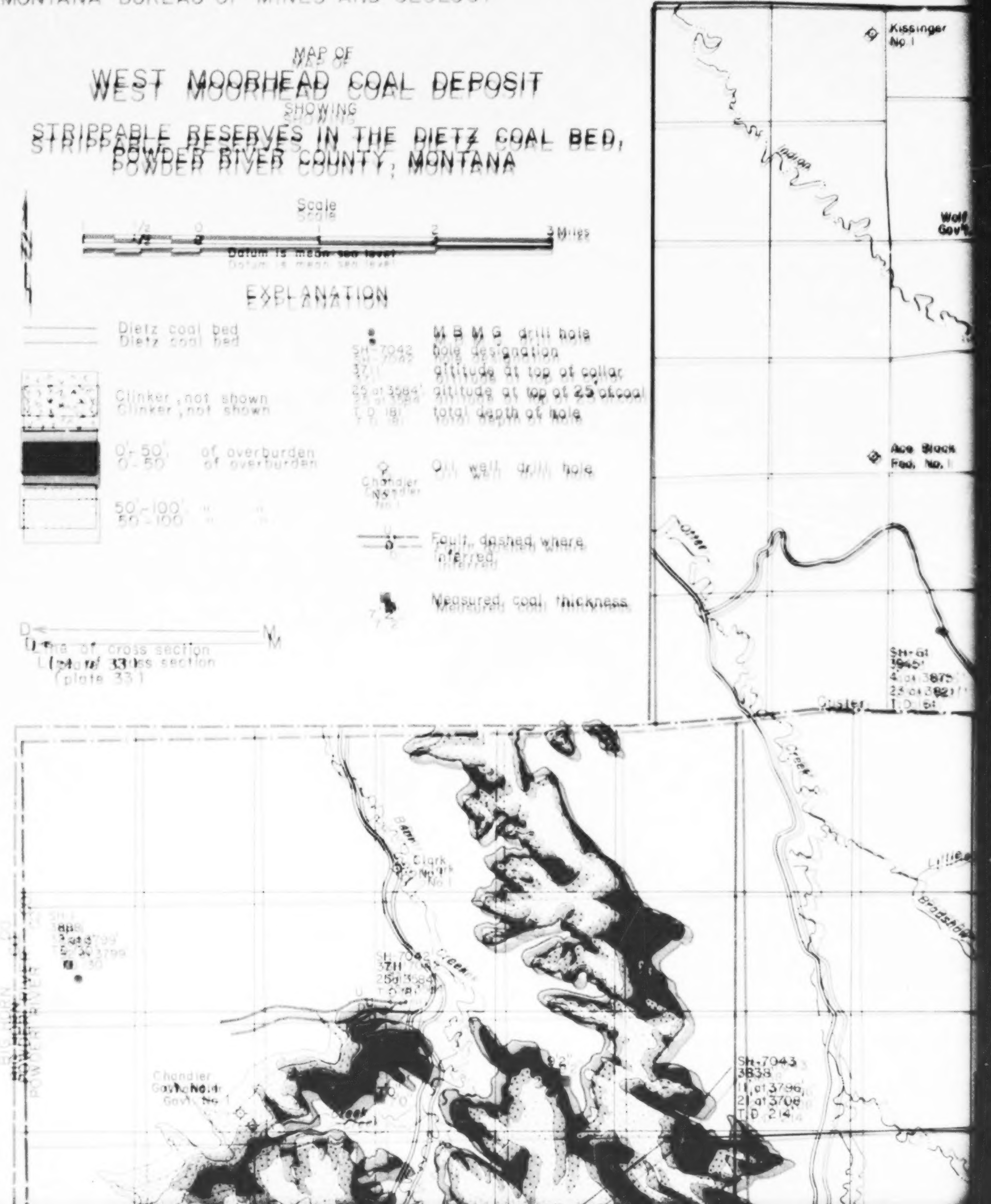
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

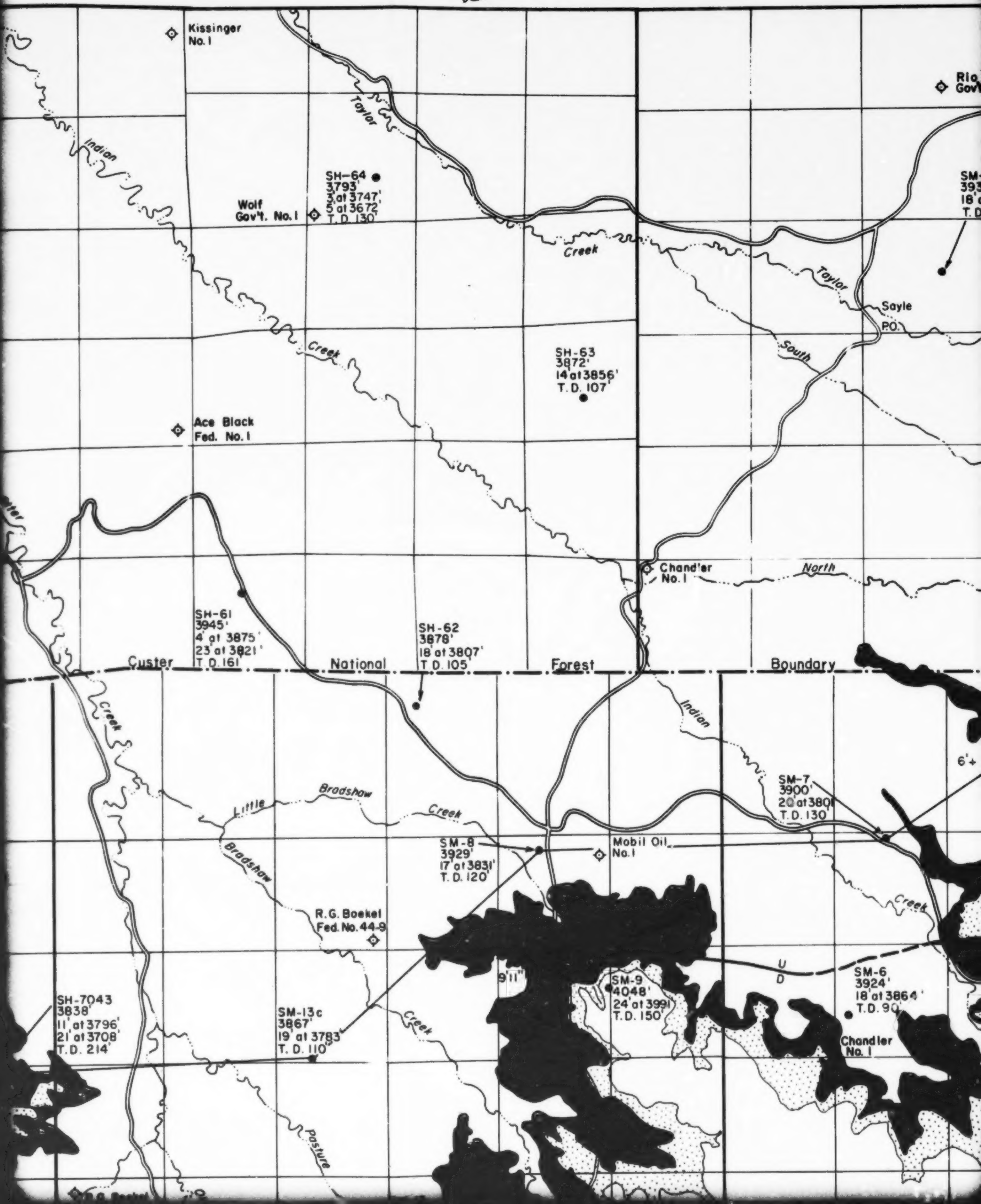
WEST MOORHEAD COAL DEPOSIT

SHOWING

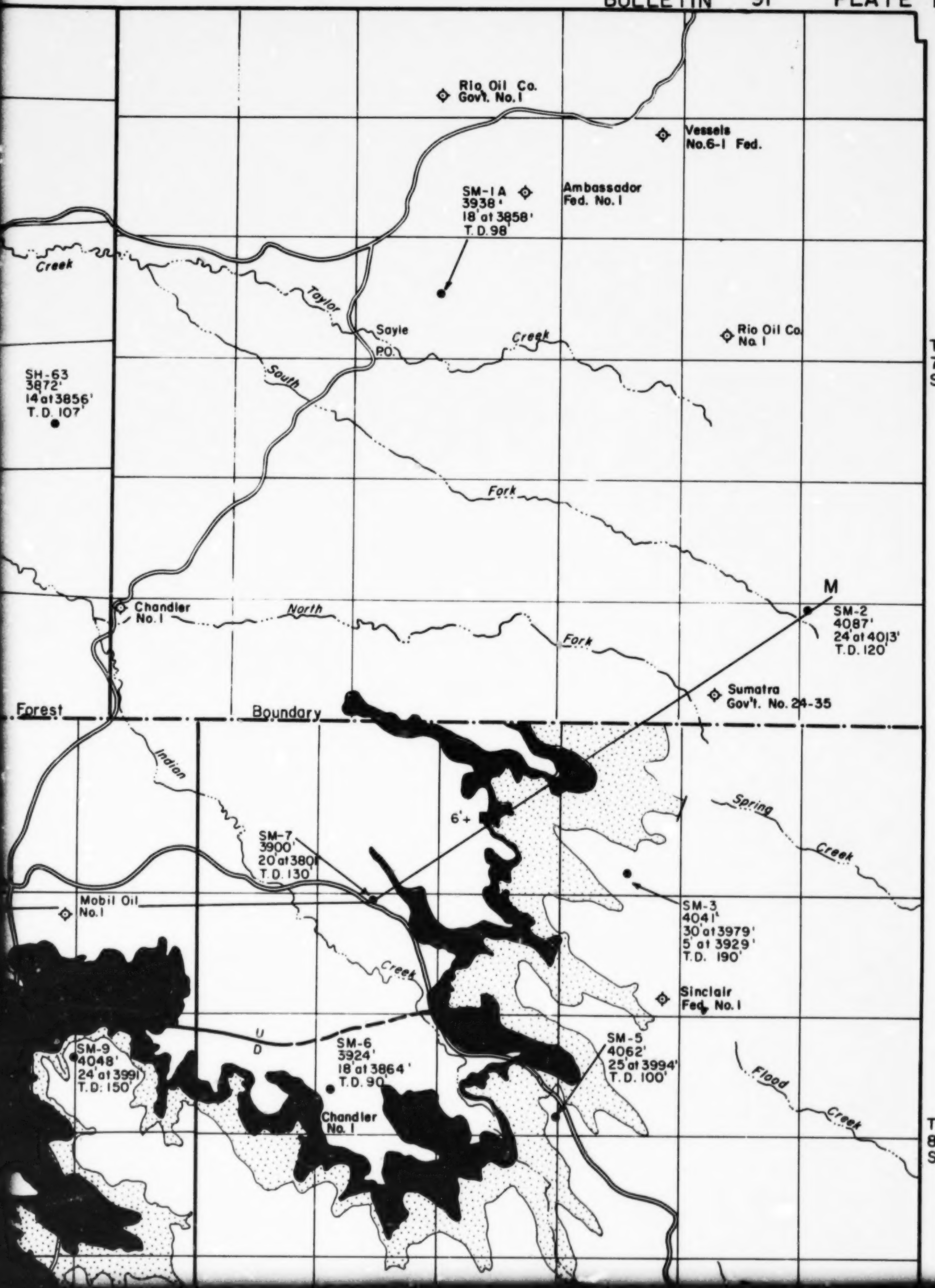
STRIPPABLE RESERVES IN THE DIETZ COAL BED, POWDER RIVER COUNTY, MONTANA

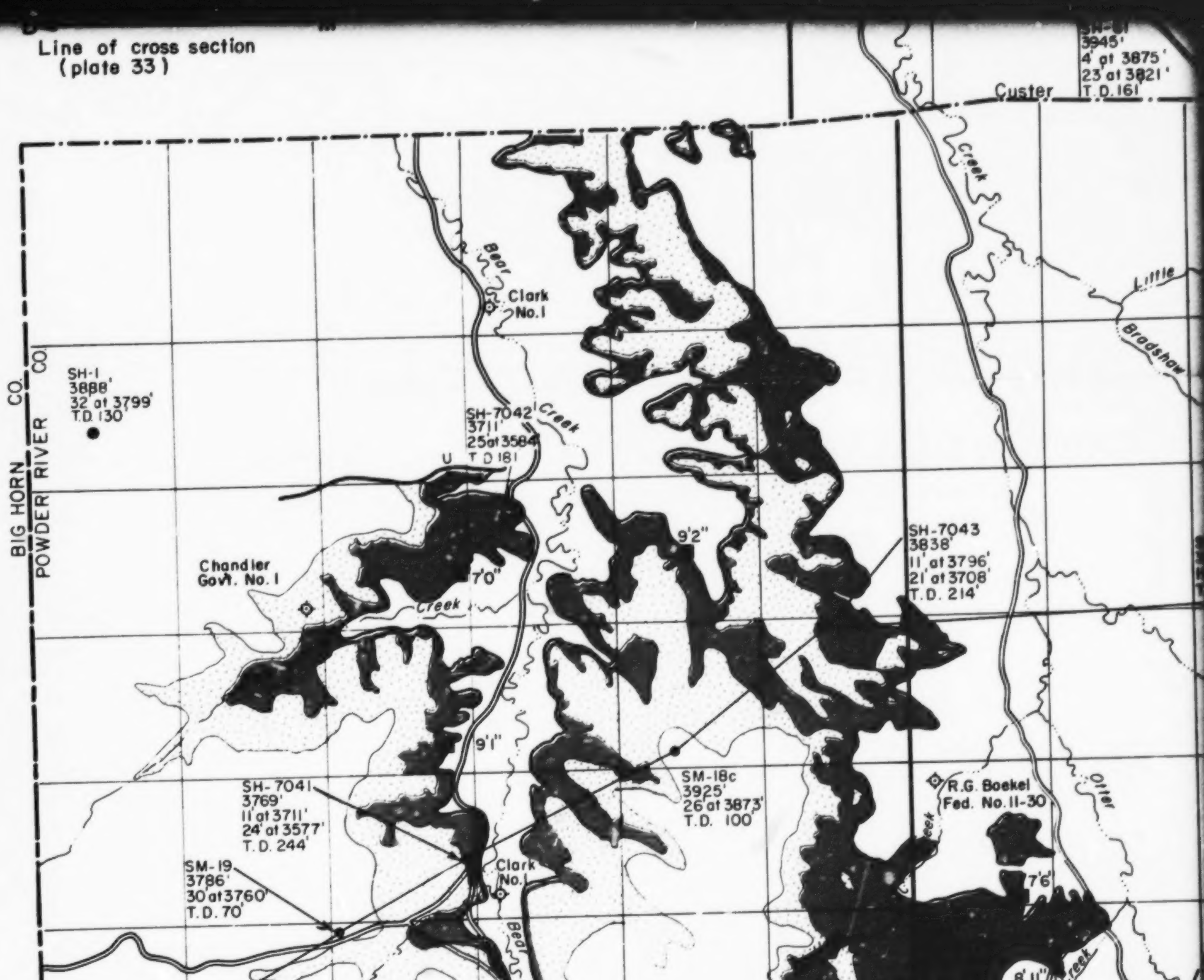

Scale
1
1/2
0
1
2
3 Miles
Datum is mean sea level
EXPLANATION
Dietz coal bed
Clinker, not shown
0'-50' of overburden
50'-100' " "
Line of cross section (plate 33)
D
M
M.B.M.G. drill hole
SH-7042 hole designation
3711 altitude at top of collar
25 at 3584' altitude at top of 25' of coal
T.D. 181 total depth of hole
Oil well drill hole
Chandler No.1
Fault, dashed where inferred
U
D
Measured coal thickness
7'2"
Kissinger No. 1
Indian
Wolf Govt.
Ace Black Fed. No. 1
SH-61
3945'
4 at 3875'
23 at 3821'
T.D. 161
Custer
Creek
Little
Bradshaw
Clark No. 1
SH-7042
3711
25 at 3584
T.D. 181
Creek
Chandler Govt. No. 1
Creek
SH-7043
3838
11 at 3796'
21 at 3708
T.D. 214
8'2"
7'0"
SH-
3888
... at 3799'
T.D. ...
BIG HORN CO.
POWDER RIVER

B


Kissinger No. 1
Taylor
Indian
SH-64 3793' 3 at 3747' 5 at 3672' T.D. 130'
Wolf Gov't. No. 1
Creek
Taylor
Sayle P.O.
South
SH-63 3872' 14 at 3856' T.D. 107'
Creek
Ace Black Fed. No. 1
Chandler No. 1
North
SH-61 3945' 4' at 3875' 23' at 3821' T.D. 161'
SH-62 3878' 18 at 3807' T.D. 105'
Custer National Forest Boundary
Creek
Indian
6'+
SM-7 3900' 20 at 380 T.D. 130'
Little Bradshaw Creek
Bradshaw
SM-8 3929' 17 at 3831' T.D. 120'
Mobil Oil No. 1
Creek
R.G. Boekel Fed. No. 44-9
9'11"
SM-9 4048' 24' at 3991 T.D. 150'
U
D
SM-6 3924' 18 at 3864' T.D. 90'
Chandler No. 1
SH-7043 3838' 11' at 3796' 21' at 3708' T.D. 214'
SM-13c 3867' 19' at 3783' T.D. 110'
Creek
Pasture
R.G. Boekel

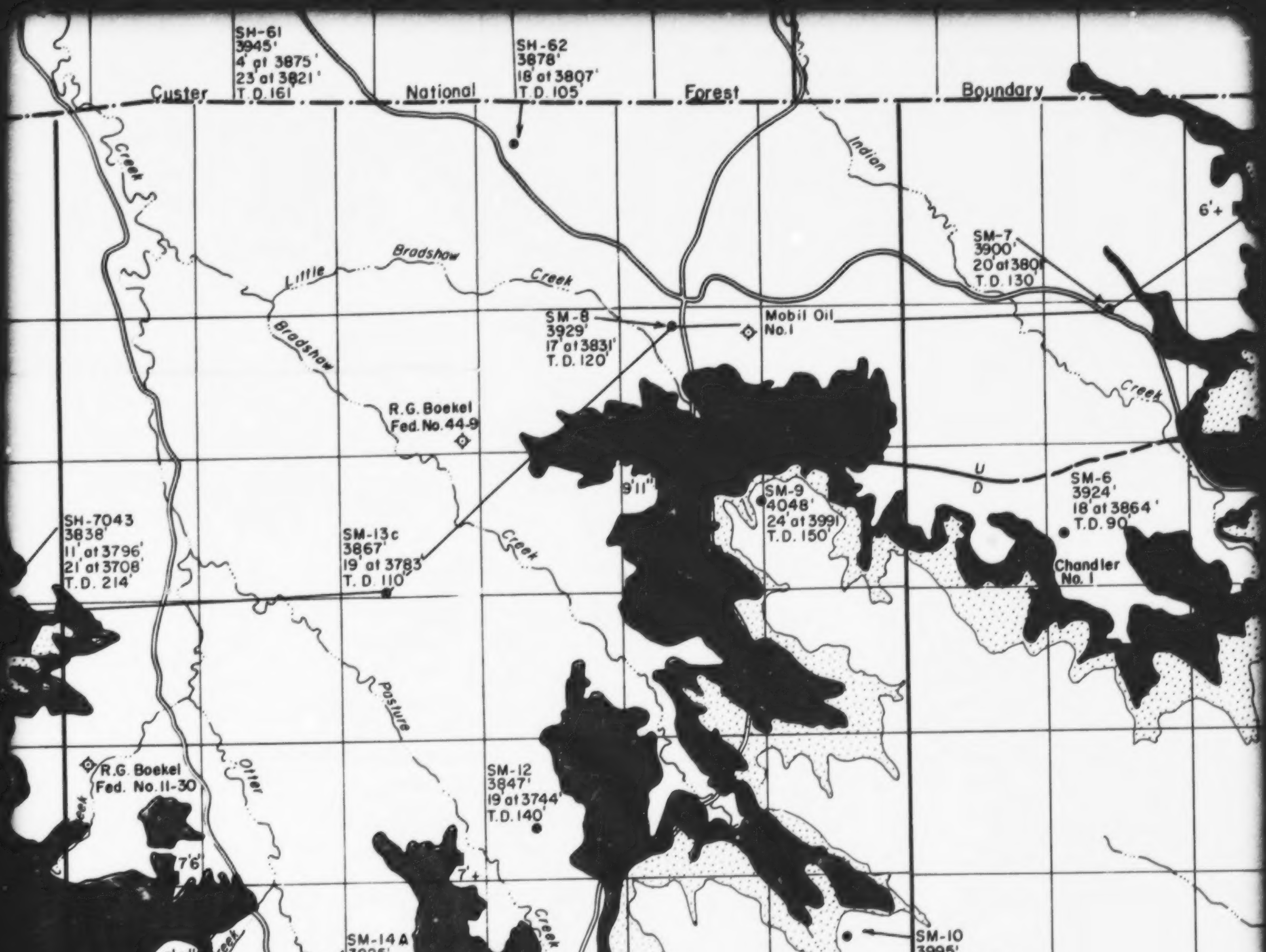
BULLETIN 91 PLATE 10 B


Rio Oil Co.
Gov't. No. 1
Vessels
No. 6-1 Fed.
SM-1A
3938'
18' at 3858'
T.D. 98'
Ambassador
Fed. No. 1
Creek
Taylor
Sayle
P.O.
Creek
Rio Oil Co.
No. 1
T.
7
S.
SH-63
3872'
14' at 3856'
T.D. 107'
South
Fork
M
Chandler
No. 1
North
Fork
SM-2
4087'
24' at 4013'
T.D. 120'
Sumatra
Gov't. No. 24-35
Forest
Boundary
Indian
Spring
Creek
6'+
SM-7
3900'
20' at 3801'
T.D. 130'
Mobil Oil
No. 1
SM-3
4041'
30' at 3979'
5' at 3929'
T.D. 190'
Creek
Sinclair
Fed. No. 1
U
D
SM-9
4048'
24' at 3991'
T.D. 150'
SM-6
3924'
18' at 3864'
T.D. 90'
SM-5
4062'
25' at 3994'
T.D. 100'
Chandler
No. 1
Flood
Creek
T.
8
S.

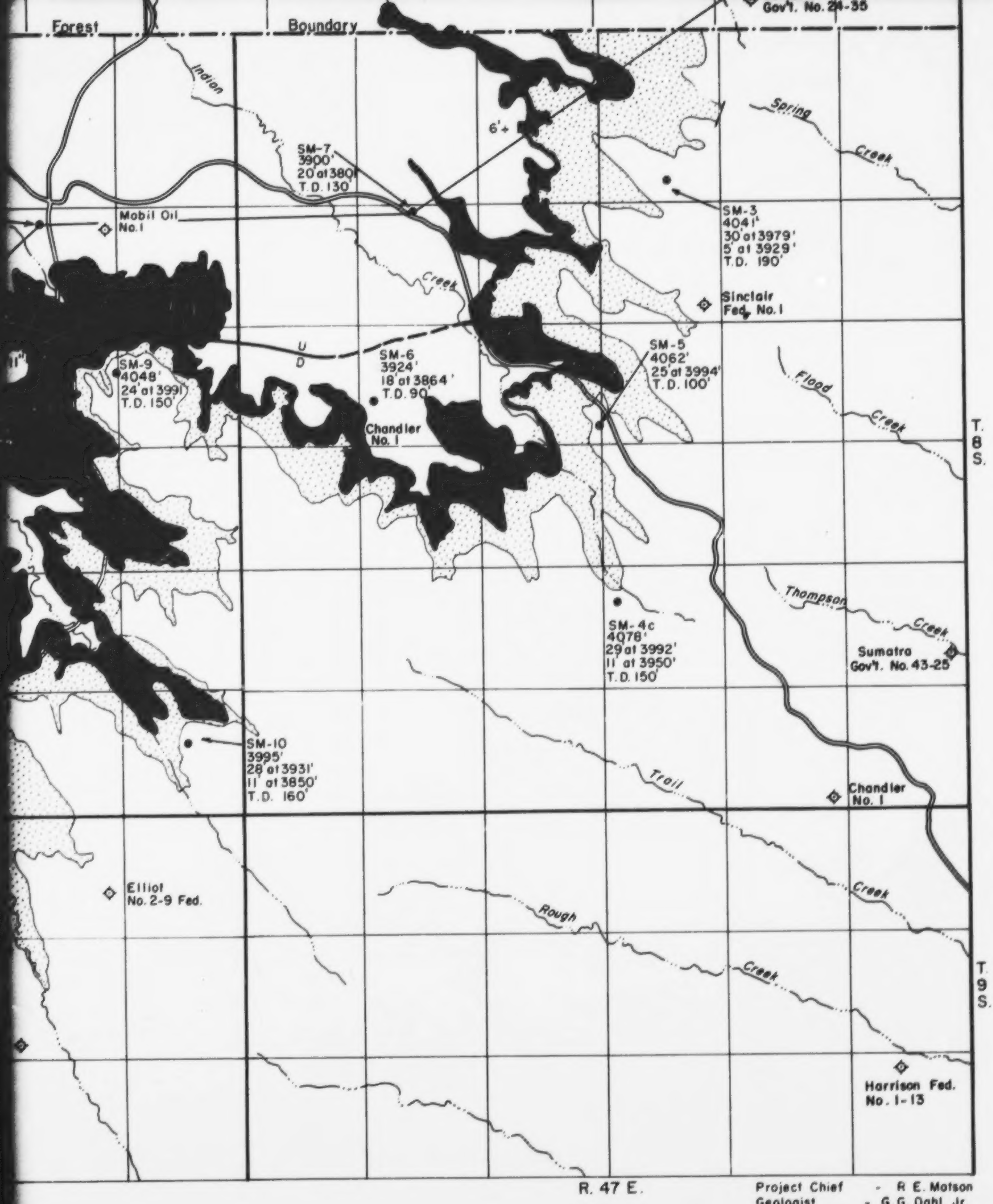


Line of cross section
(plate 33)
3945'
4' at 3875'
23' at 3821'
T.D. 161
Custer
Creek
Little
Bradshaw
Bear
Clark
No. 1
BIG HORN CO.
POWDER RIVER CO.
SH-1
3888'
32 at 3799'
T.D. 130'
SH-7042
3711'
25 at 3584
T.D. 181
Creek
U
Chandler
Govt. No. 1
7'0"
Creek
9'2"
SH-7043
3838'
11' at 3796'
21' at 3708'
T.D. 214'
9'1"
SM-18c
3925'
26' at 3873'
T.D. 100'
R.G. Boekel
Fed. No. 11-30
Otter
Creek
SH-7041
3769'
11' at 3711'
24' at 3577'
T.D. 244'
Clark
No. 1
SM-19
3786'
30 at 3760'
T.D. 70'
Bear
7'6"
8'11"
Creek
D
True-Champlin
Fed. No. 11-6
Vance
SM-17
3820'
19' at 3777'
T.D. 100'
Gulf Oil Corp.
Boxelder
East
Creek
Fork
Creek
True Oil Co.
No. 1
R. 45 E.

Base map from 1966 U.S.G.S. open-file rept. by R.P. Bryson and N.W. Bass on the Moorhead coal field. (scale 1" = 1 mile)


SH-61
3945'
4' at 3875'
23' at 3821'
T.D. 161
SH-62
3878'
18' at 3807'
T.D. 105'
Custer
National
Forest
Boundary
Creek
Indian
6'+
SM-7
3900'
20' at 380
T.D. 130'
Little
Bradshaw
Creek
Bradshaw
SM-8
3929'
17' at 3831'
T.D. 120'
Mobil Oil
No. 1
Creek
R.G. Boekel
Fed. No. 44-9
9'11"
SM-9
4048'
24' at 3991
T.D. 150'
U
D
SM-6
3924'
18' at 3864'
T.D. 90'
Chandler
No. 1
SH-7043
3838'
11' at 3796'
21' at 3708'
T.D. 214'
SM-13c
3867'
19' at 3783'
T.D. 110
Creek
Pasture
R.G. Boekel
Fed. No. 11-30
Otter
eek
SM-12
3847'
19' at 3744'
T.D. 140'
7'6"
7'+
Creek
8'11"
Creek
SM-14A
3825'
9' at
5' at
20' at 365
T.D. 197'
SM-10
3995'
28' at 3931'
11' at 3850'
T.D. 160'
Creek
Elliot
No. 2-9 Fed.
Lockelder
SM-11
3943'
29' at 3872'
11' at 3797'
T.D. 159'
Westrans
No. 14-11
SM-15c
3953'
14' at 3889'
6' at 3849'
T.D. 150'
True Oil Co.
No. 1
R. 46 E.

6


Gov't. No. 24-35
Forest
Boundary
Indian
Creek
Spring
Creek
6'+
SM-7
3900'
20'at 3801
T.D. 130'
Mobil Oil
No. 1
SM-3
4041'
30'at 3979'
5' at 3929'
T.D. 190'
Sinclair
Fed. No. 1
U
D
SM-9
4048'
24'at 3991
T.D. 150'
SM-6
3924'
18'at 3864'
T.D. 90'
Chandler
No. 1
SM-5
4062'
25'at 3994'
T.D. 100'
Flood
Creek
T.
8
S.
Thompson
Creek
SM-4c
4078'
29'at 3992'
11' at 3950'
T.D. 150'
Sumatra
Gov't. No. 43-25
SM-10
3995'
28'at 3931'
11' at 3850'
T.D. 160'
Trail
Creek
Chandler
No. 1
Elliot
No. 2-9 Fed.
Rough
Creek
T.
9
S.
Harrison Fed.
No. 1-13
R. 47 E.

Project Chief - R E. Matson
Geologist - G. G. Dahl Jr.
Draftsman - E. A. Woods

MONTANA BUREAU OF MINES AND GEOLOGY

A

MAP OF
WEST MOORHEAD COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE CANYON COAL BED, POWDER RIVER COUNTY, MONTANA

Scale

Datum is mean sea level

EXPLANATION

— Canyon coal bed

▨ Clinker

■ 0'-50' of overburden

▨ 50'-100' " "

▨ 100'-150' " "

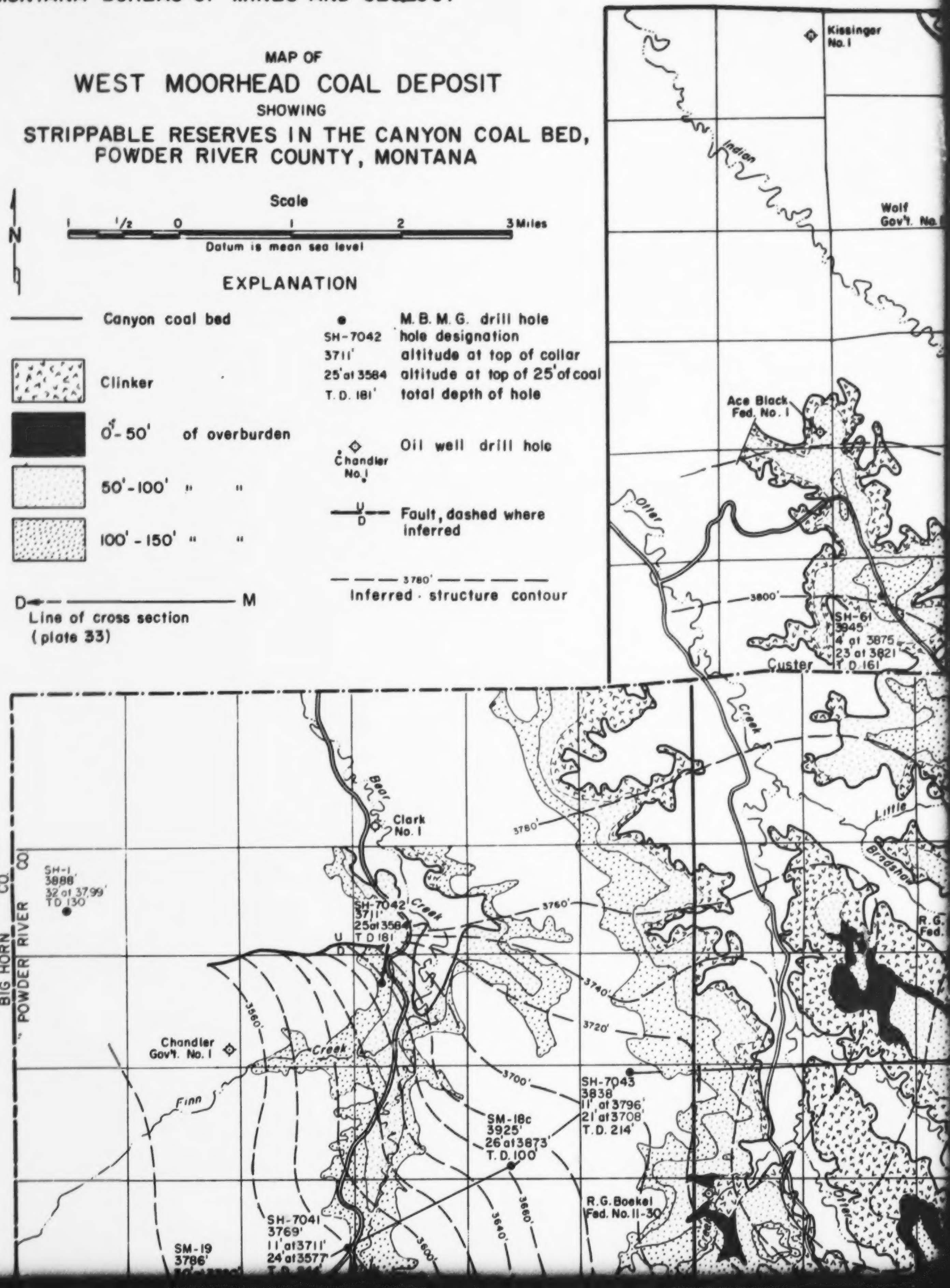
D◄— —M Line of cross section (plate 33)

●	M. B. M. G. drill hole
SH-7042	hole designation
3711'	altitude at top of collar
25' at 3584	altitude at top of 25' of coal
T. D. 181'	total depth of hole

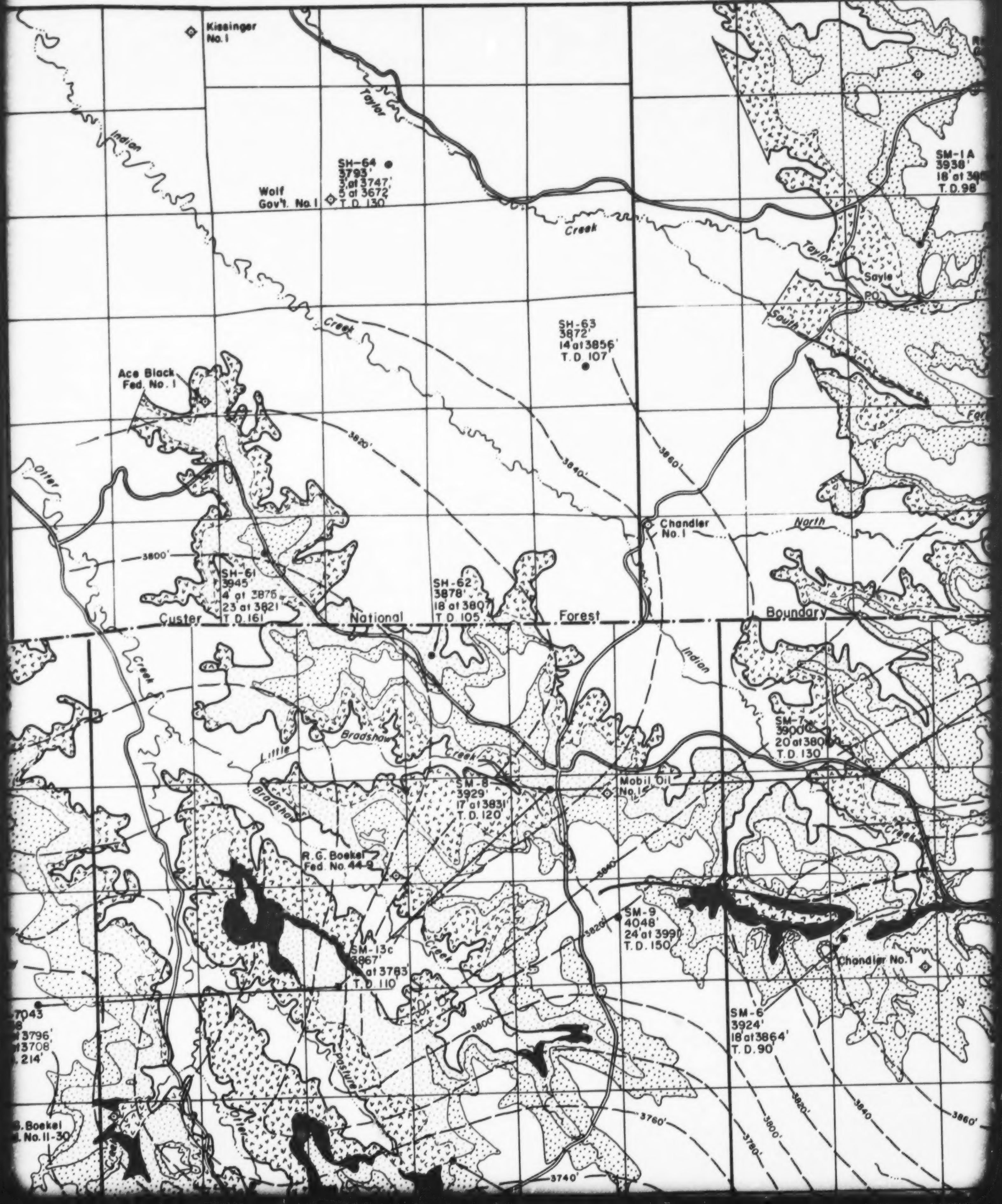
◇ Chandler No. 1 Oil well drill hole

U/D Fault, dashed where inferred

— — — 3780' — — — Inferred structure contour


N
1
1/2
0
1
2
3 Miles
Kissinger No. 1
Indian
Wolf Gov't. No.
Ace Black Fed. No. 1
Otter
3800'
SH-61
3945
4 at 3875
23 at 3821
T.D. 161
Custer
Creek
Little
Bradshaw
Bear
Clark No. 1
3780'
3760'
BIG HORN CO.
POWDER RIVER CO.
SH-1
3888'
32 at 37.99'
TD 130
SH-7042
3711'
25 at 3584
T D 181
U
D
3740'
3720'
3700'
R.G. Fed.
Chandler Gov't. No. 1
Creek
Finn
3560'
SH-7043
3838
11' at 3796'
21' at 3708'
T.D. 214'
SM-18c
3925'
26 at 3873'
T.D. 100'
3680'
3660'
3640'
3600'
R.G. Boekel Fed. No. 11-30
Otter
Creek
SH-7041
3769'
11' at 3711'
24' at 3577'
SM-19
3786'

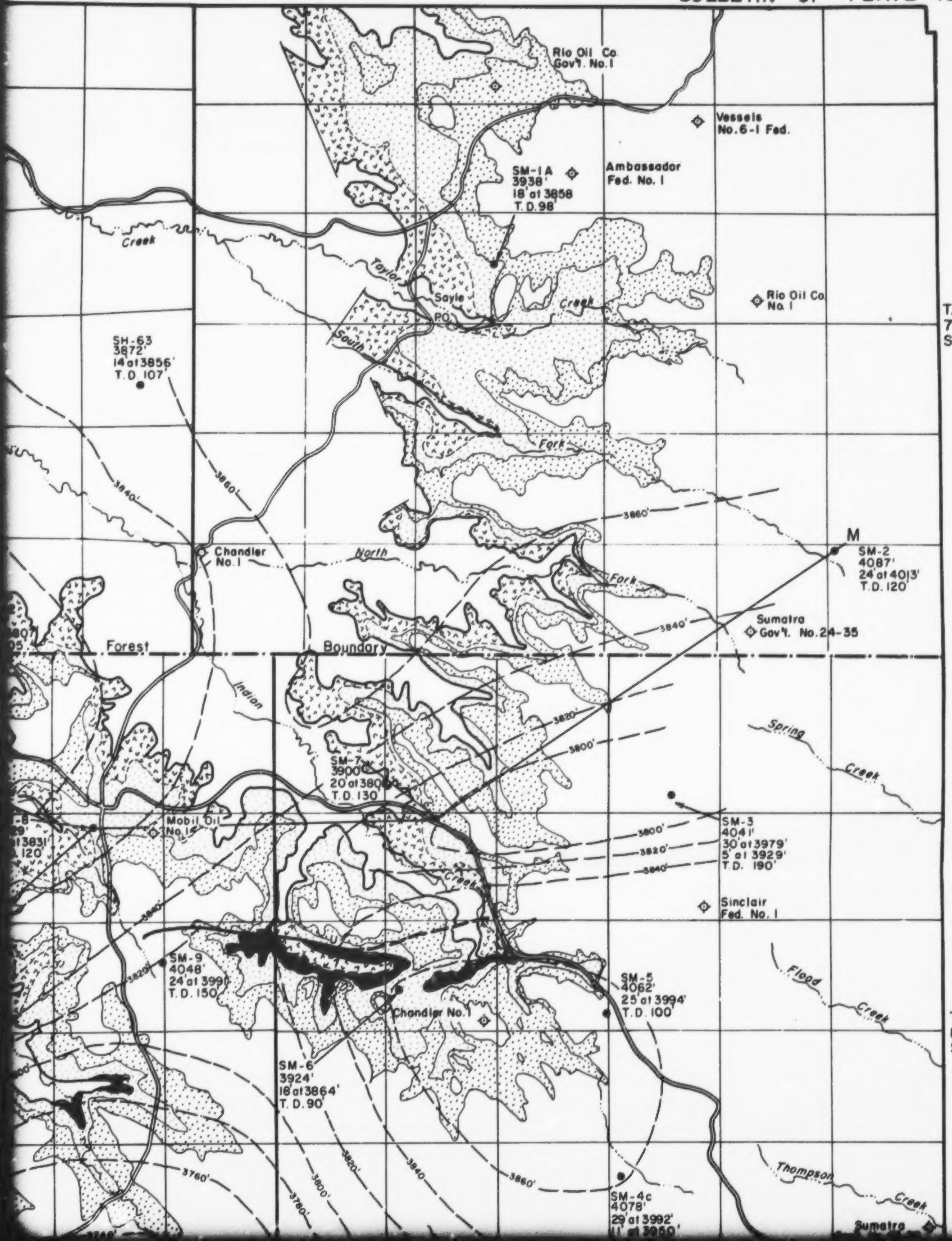
B

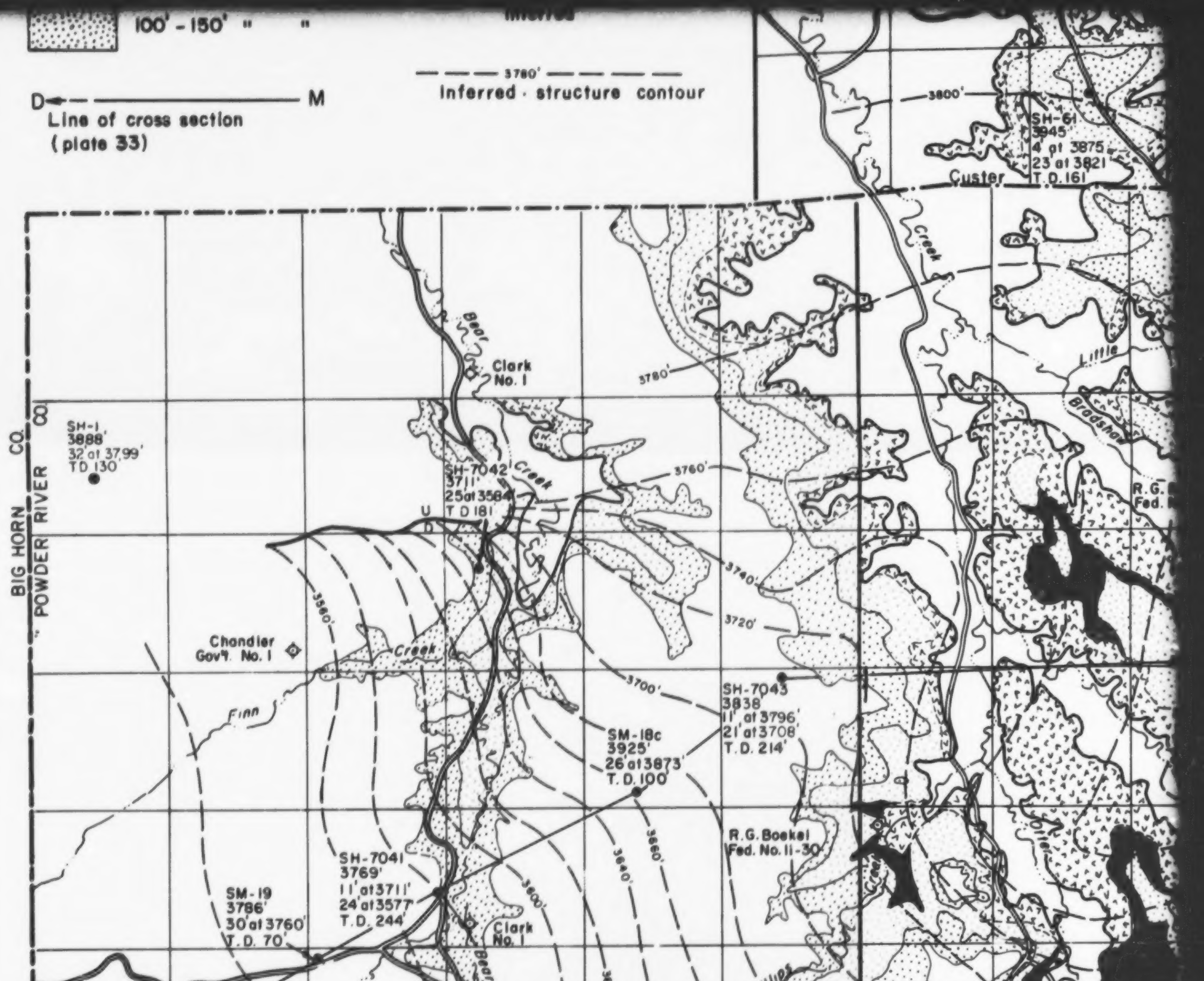

Kissinger
No. 1
Taylor
Indian
SH-64
3793'
3 at 3747'
5 at 3672'
T.D. 130
Wolf
Gov't. No. 1
Creek
Taylor
Sayle
P.O.
South
SM-1A
3938'
T.D. 98
SH-63
3872'
14 at 3856'
T.D. 107
Creek
Ace Black
Fed. No. 1
3820'
3840'
3860'
Otter
Chandler
No. 1
North
3800'
SH-61
3945
4 at 3875
23 at 3821
T.D. 161
SH-62
3878'
18 at 3807
T.D. 105
Custer
National
Forest
Boundary
Creek
Indian
Little
Bradshaw
Creek
SM-7
3900'
20 at 380
T.D. 130
SM-8
3929'
17 at 3831'
T.D. 120
Mobil Oil
No. 1
Bradshaw
R. G. Boekel
Fed. No. 44-9
Creek
3840'
SM-9
4048'
24 at 3991
T.D. 150
3820'
Creek
SM-13c
3867'
at 3783'
T.D. 110
Chandler No. 1
3800'
SM-6
3924'
18 at 3864'
T.D. 90
3796'
3708'
214'
Pasture
Otter
Boekel
No. 11-30
3760'
3820'
3840'
3860'
3800'
3780'
3740'

B

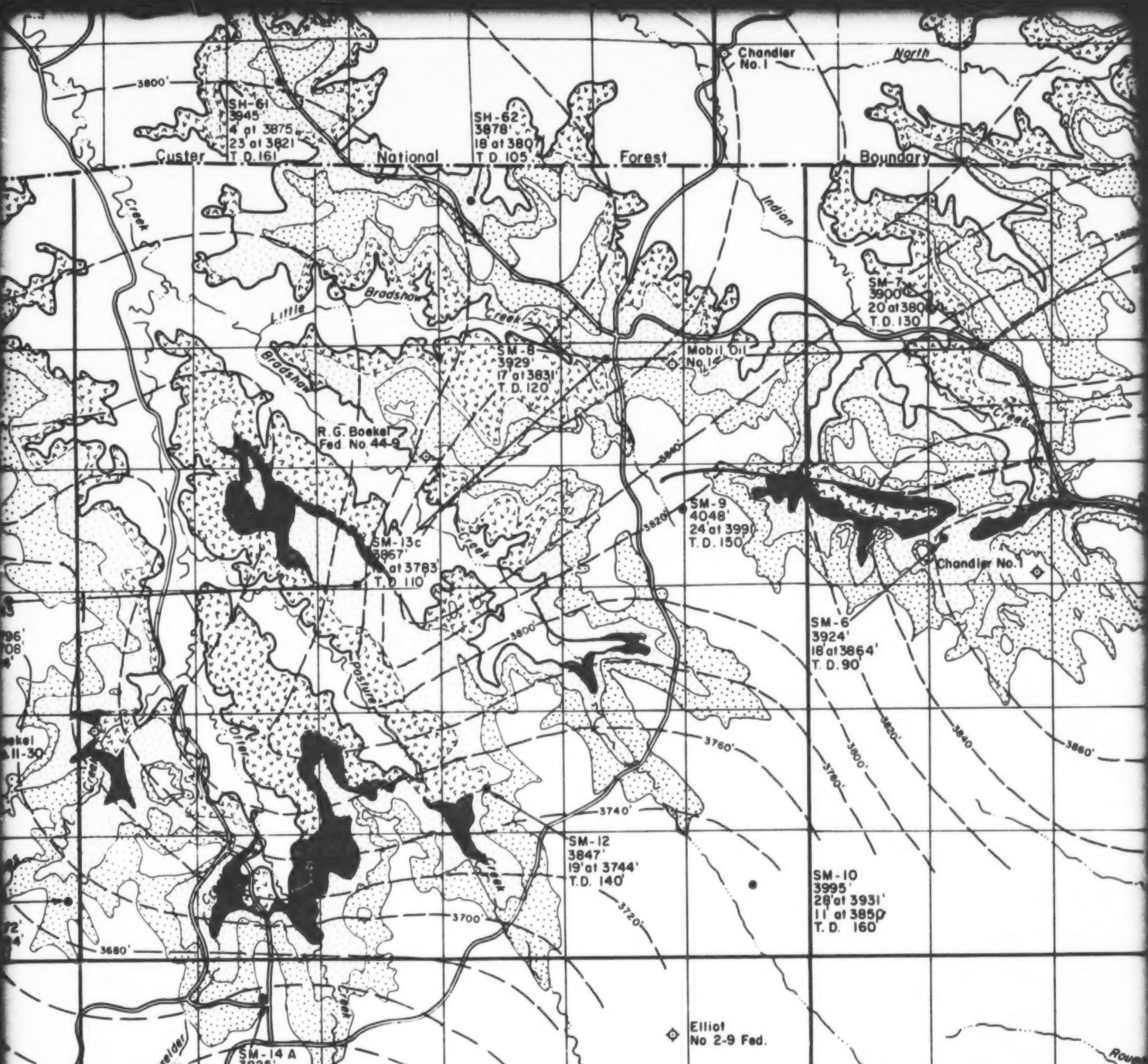
BULLETIN 91 PLATE 10C

C

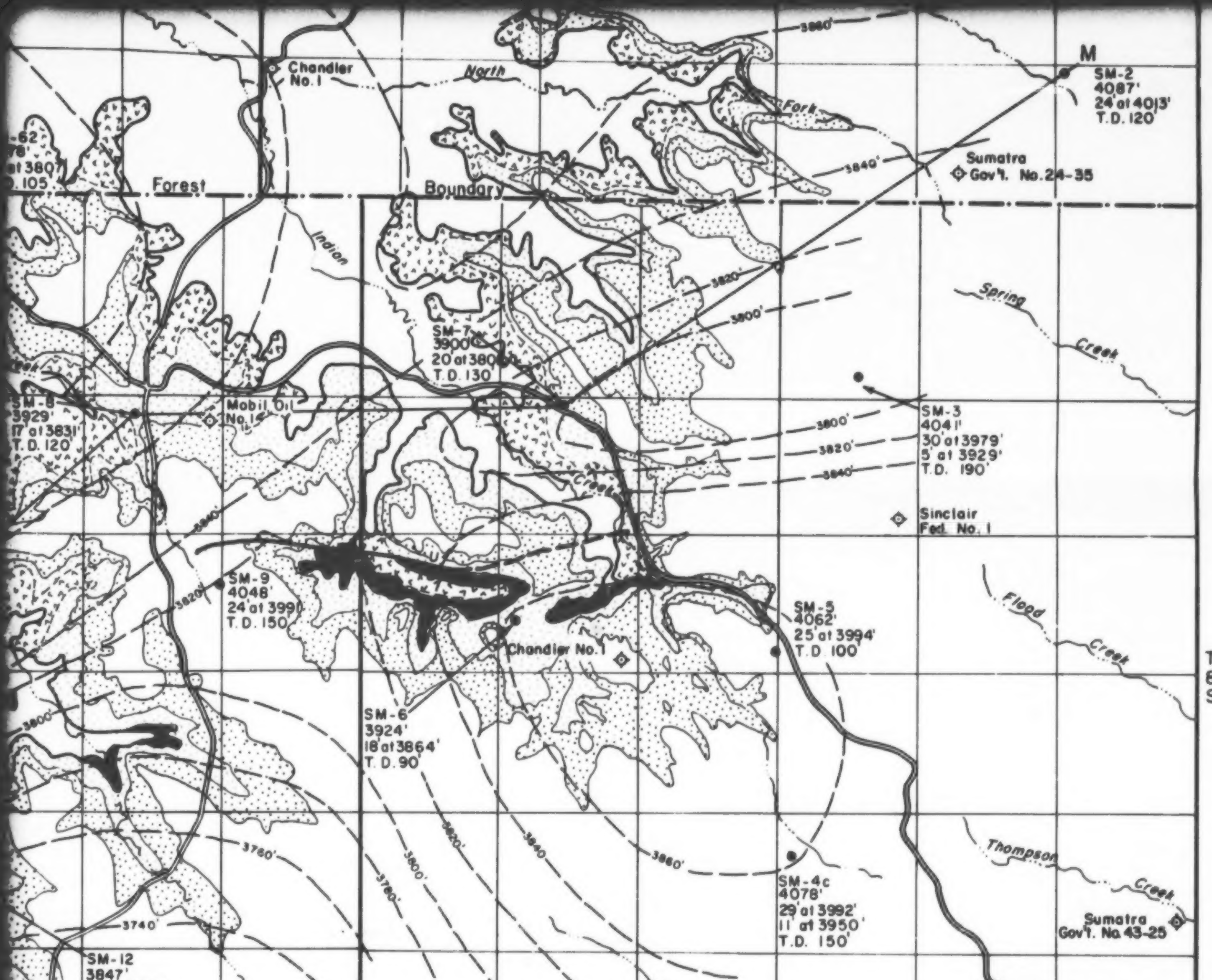

Rio Oil Co.
Gov't. No. 1
Vessels
No. 6-1 Fed.
SM-1A
3938'
18' at 3858
T.D. 98'
Ambassador
Fed. No. 1
Creek
Taylor
Sayle
P.O.
Creek
Rio Oil Co.
No. 1
T.
7
S.
SH-63
3872'
14' at 3856'
T.D. 107'
South
Fork
3840'
3860'
3860'
M
SM-2
4087'
24' at 4013'
T.D. 120'
Chandler
No. 1
North
Fork
Sumatra
Gov't. No. 24-35
3840'
Forest
Boundary
Indian
3820'
3800'
Spring
Creek
SM-7
3900'
20 at 3800
T.D. 130'
Mobil Oil
No. 15
SM-3
4041'
30' at 3979'
5' at 3929'
T.D. 190'
3800'
3820'
3840'
Creek
3831'
120'
3860'
Sinclair
Fed. No. 1
SM-9
4048'
24' at 3991
T.D. 150'
3820'
SM-5
4062'
25' at 3994'
T.D. 100'
Chandler No. 1
Flood
Creek
T.
8
S.
SM-6
3924'
18' at 3864'
T.D. 90'
3760'
3820'
3840
3860'
3800'
3780'
3740'
Thompson
Creek
SM-4c
4078'
29' at 3992'
11' at 3950'
Sumatra


100'-150' " "
Inferred
D — M
Line of cross section (plate 33)
3760'
Inferred structure contour
Custer Creek
SH-61
3945'
4 at 3875'
23 at 3821'
T.D. 161'
3800'
3780'
3760'
3740'
3720'
3700'
3680'
3660'
3640'
3620'
3600'
3580'
3560'
3540'
Little
Bradshaw
Bear Creek
Clark No. 1
BIG HORN CO.
POWDER RIVER CO.
SH-1
3888'
32 at 37.99'
T.D. 130'
SH-7042
3711'
25 at 3584'
T.D. 181'
U
D
Chandler Gov't. No. 1
Creek
Finn
SH-7043
3838'
11' at 3796'
21' at 3708'
T.D. 214'
SM-18c
3925'
26' at 3873'
T.D. 100'
R.G. Boekel Fed. No. 11-30
R.G. B Fed.
SH-7041
3769'
11' at 3711'
24' at 3577'
T.D. 244'
SM-19
3786'
30' at 3760'
T.D. 70'
Clark No. 1
Bear
Phillips
Creek
SM-16
3812'
11 at 3772'
18 at 3694'
T.D. 150'
SM-17
3820'
19 at 3777'
T.D. 100'
D
True-Champlin Fed. No. 11-6
Vance
Creek
Boxelder
SM-14 A
3825'
8 at 3772'
5' at 3660'
20 at 3650'
T.D. 195'
Gulf Oil Corp.
East Fork Creek
True Oil Co.
SM-
395
14
6
T.D.
R. 45 E.

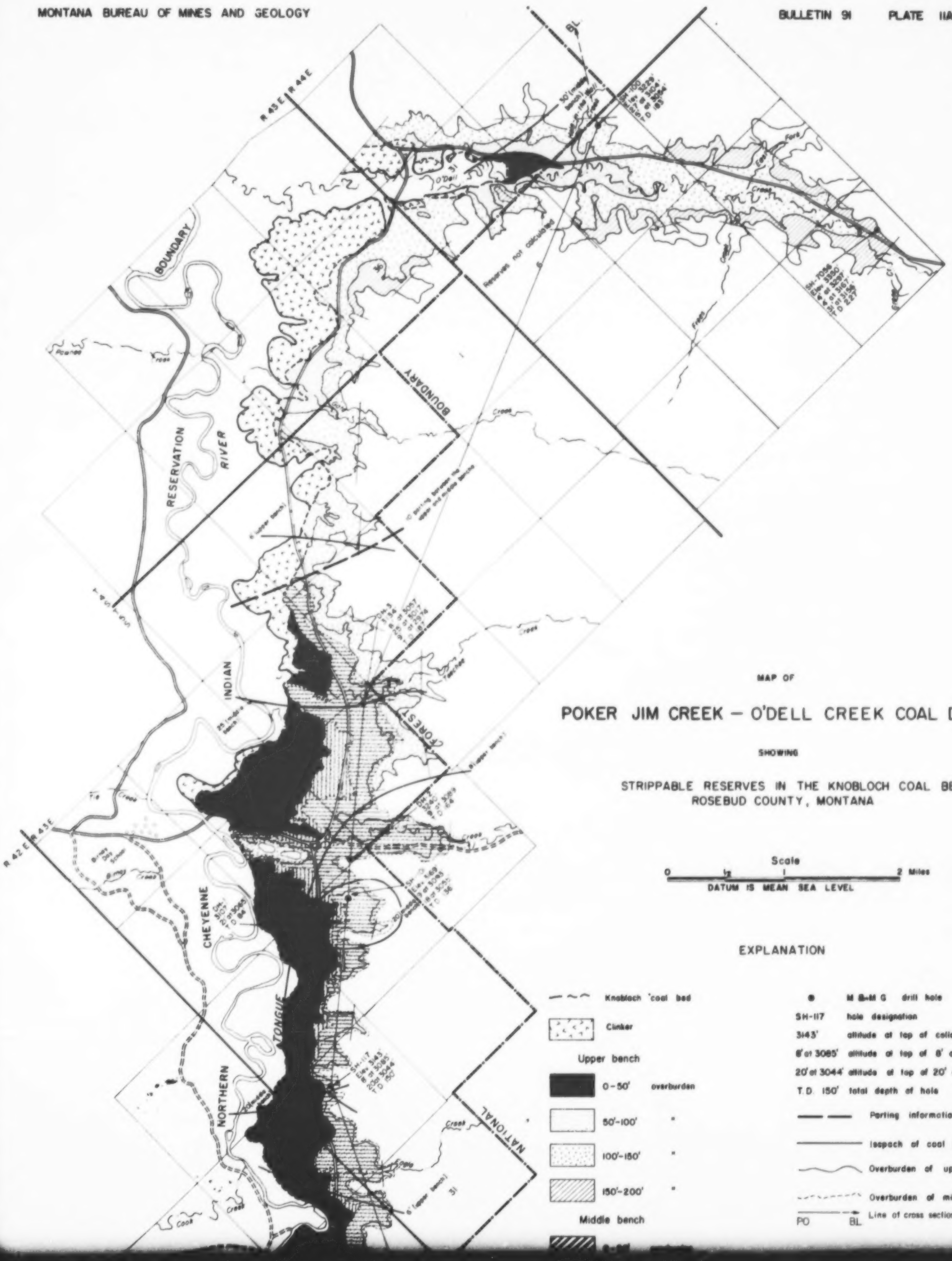
Base map from 1966 U.S.G.S. open-file rept. by R.P. Bryson and N.W. Bass on the Moorhead coal field. (scale 1" = 1 mile)


3800'
SH-61
3945
4 at 3875
23 at 3821
T.D. 161
SH-62
3878'
18 at 380
T.D. 105
Chandler
No. 1
North
Custer
National
Forest
Boundary
Creek
Indian
Little
Bradshaw
Creek
Bradshaw
SM-7
3900
20 at 380
T.D. 130
SM-8
3929'
17 at 3831'
T.D. 120'
Mobil Oil
No. 1
R. G. Boekel
Fed. No. 44-9
Creek
3840'
3820'
SM-9
4048'
24 at 3991
T.D. 150
SM-13c
3867'
at 3783'
T.D. 110
Chandler No. 1
SM-6
3924'
18 at 3864'
T.D. 90'
3800'
Pasture
Otter
Creek
3820'
3840
3860'
3760'
3800'
3780'
3740'
SM-12
3847'
19' at 3744'
T.D. 140'
3720'
SM-10
3995'
28' at 3931'
11' at 3850
T.D. 160
3700'
3680'
Creek
Boxelder
Elliot
No. 2-9 Fed.
Rouge
SM-14 A
3825'
9' at 3772'
5' at 3660'
20 at 3650'
T.D. 195'
SM-11
3943'
29' at 3872'
11' at 3797'
T.D. 159'
3620'
Westrans
No. 14-11
SM-15c
3953'
14 at 3889'
6 at 3849'
T.D. 150'
True Oil Co.
R. 46 E.

E


M
SM-2
4087'
24' at 4013'
T.D. 120'
Chandler
No. 1
North
Fork
3880'
3840'
Sumatra
Gov't. No. 24-35
Forest
Boundary
Indian
Spring
Creek
3820'
3800'
SM-7
3900'
20' at 380
T.D. 130
SM-8
3929'
17' at 3831'
T.D. 120'
Mobil Oil
No. 1
SM-3
4041'
30' at 3979'
5' at 3929'
T.D. 190'
3800'
3820'
3840'
Creek
Sinclair
Fed. No. 1
3840
3820
SM-9
4048'
24' at 3991
T.D. 150'
SM-5
4062'
25' at 3994'
T.D. 100'
Chandler No. 1
Flood
Creek
T.
8
S.
3800
SM-6
3924'
18' at 3864'
T.D. 90'
3820'
3840
3800'
3780'
3760'
3860'
SM-4c
4078'
29' at 3992'
11' at 3950'
T.D. 150'
Thompson
Creek
Sumatra
Gov't. No. 43-25
3740'
SM-12
3847'
19' at 3744'
T.D. 140'
SM-10
3995'
28' at 3931'
11' at 3850
T.D. 160
3720'
Trail
Chandler
No. 1
Elliot
No. 2-9 Fed.
Creek
Rough
Creek
T
9
S.
Harrison Fed.
No. 1-13
R. 47 E.

Project Chief and Geologist — R. E. Matson
Draftsman — E. A. Woods


BL
R 43 E
R 44 E
R 42 E
R 43 E
BOUNDARY
RESERVATION
RIVER
INDIAN
CHEYENNE
NORTHERN
TONGUE
BOUNDARY
FOREST
NATIONAL
O'Dell
Creek
Reserves not calculated
SH-100
SH-7056
SH-117
Elev 3143'
8' at 3085'
20' at 3044'
T.D. 150'
Pawnee
Creek
Tie
Creek
Cook
Creek
Bray
Creek
East Fork
31
36
31
6' (upper bench)
20' (middle bench)
25' (middle bench)
30' (middle bench)
6' (upper bench)

MAP OF

POKER JIM CREEK – O'DELL CREEK COAL DEPOSI

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED,
ROSEBUD COUNTY, MONTANA

Scale
0 ½ 1 2 Miles
DATUM IS MEAN SEA LEVEL

EXPLANATION

Knobloch coal bed

Clinker

Upper bench

0-50' overburden

50'-100' "

100'-150' "

150'-200' "

Middle bench

● M B-M G drill hole

SH-117 hole designation

3143' altitude at top of collar

8' at 3085' altitude at top of 8' of coal

20' at 3044' altitude at top of 20' of coal

T.D. 150' total depth of hole

Parting information

Isopach of coal bed

Overburden of upper bench

Overburden of middle bench

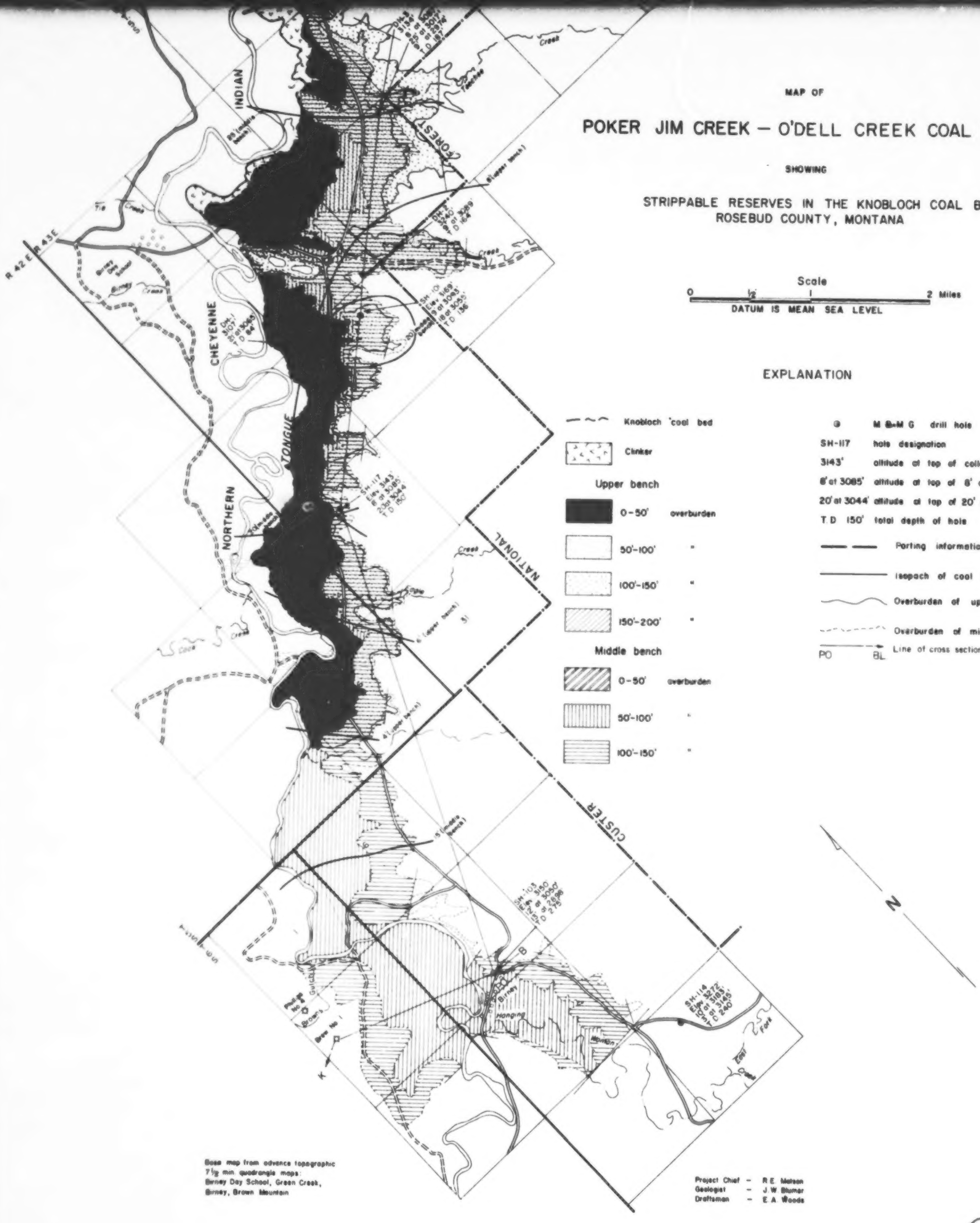
PO BL Line of cross section (plate 34)

MAP OF

POKER JIM CREEK — O'DELL CREEK COAL DEPOS

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED, ROSEBUD COUNTY, MONTANA



Scale
0 1/2 1 2 Miles
DATUM IS MEAN SEA LEVEL
INDIAN
FOREST
CHEYENNE
NORTHERN
TONGUE
NATIONAL
CUSTER
R 42 E R 43 E
Creek
Birney
Hanging
Woman
East Fork
Browns
Gulch
SH-117
Elev 3143
8' at 3085'
20' at 3044'
T D 150'
SH-101
SH-103
SH-114
B
K
N

EXPLANATION

- — ~ — Knobloch coal bed
- Clinker

Upper bench

- ■ 0–50' overburden
- ☐ 50'–100' "
- 100'–150' "
- ▨ 150'–200' "

Middle bench

- ▨ 0–50' overburden
- ▥ 50'–100' "
- ▤ 100'–150' "

●	M B&M G drill hole
SH-117	hole designation
3143'	altitude at top of collar
8' at 3085'	altitude at top of 8' of coal
20' at 3044'	altitude at top of 20' of coal
T.D 150'	total depth of hole
— —	Parting information
——	Isopach of coal bed
～	Overburden of upper bench
- - -	Overburden of middle bench
PO → BL	Line of cross section (plate 34)

Base map from advance topographic
7½ min quadrangle maps:
Birney Day School, Green Creek,
Birney, Brown Mountain

Project Chief – R.E. Matson
Geologist – J.W. Blumer
Draftsman – E.A. Woods

B

BULLETIN 91 PLATE 11 B

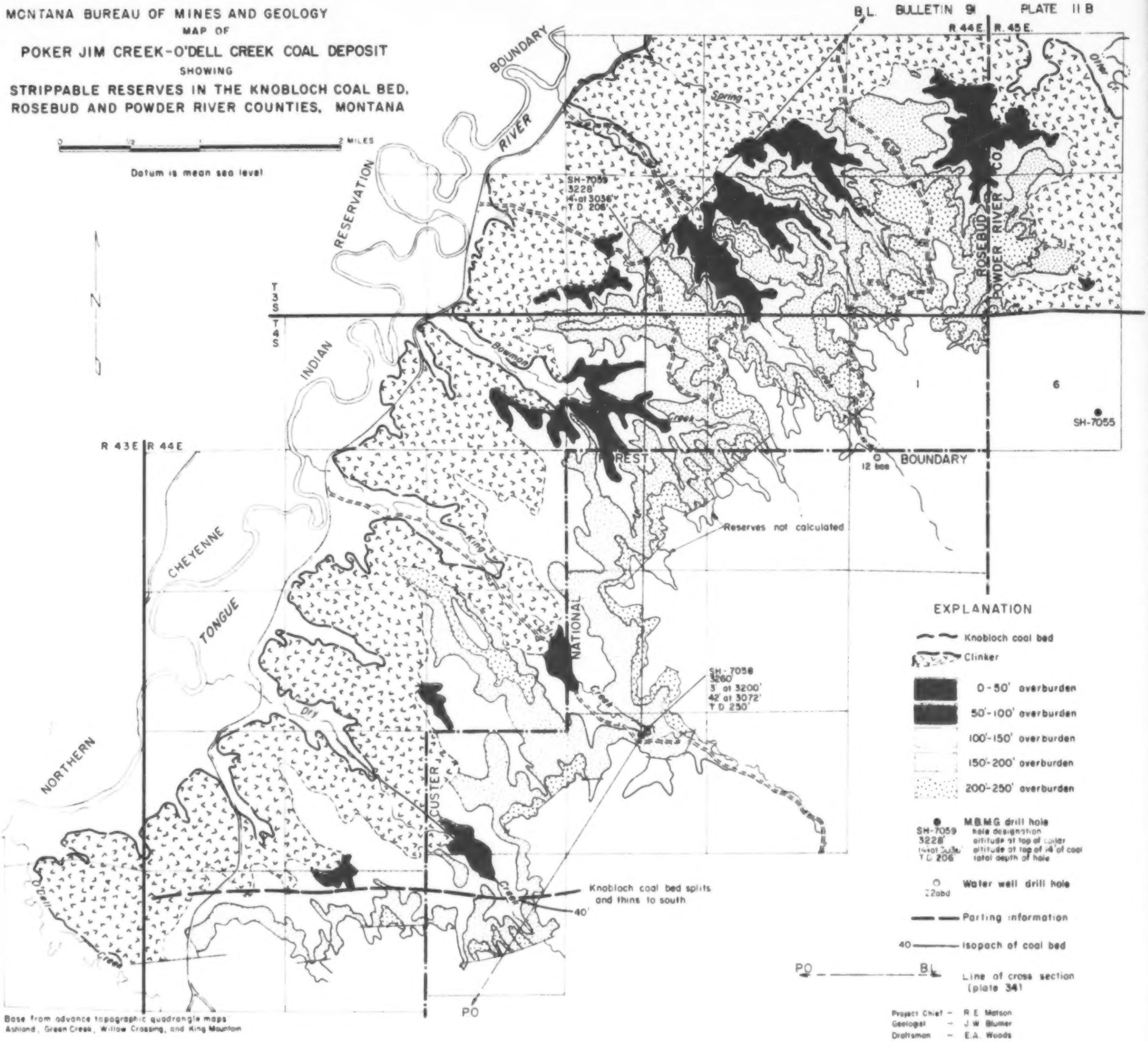
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

POKER JIM CREEK-O'DELL CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED, ROSEBUD AND POWDER RIVER COUNTIES, MONTANA

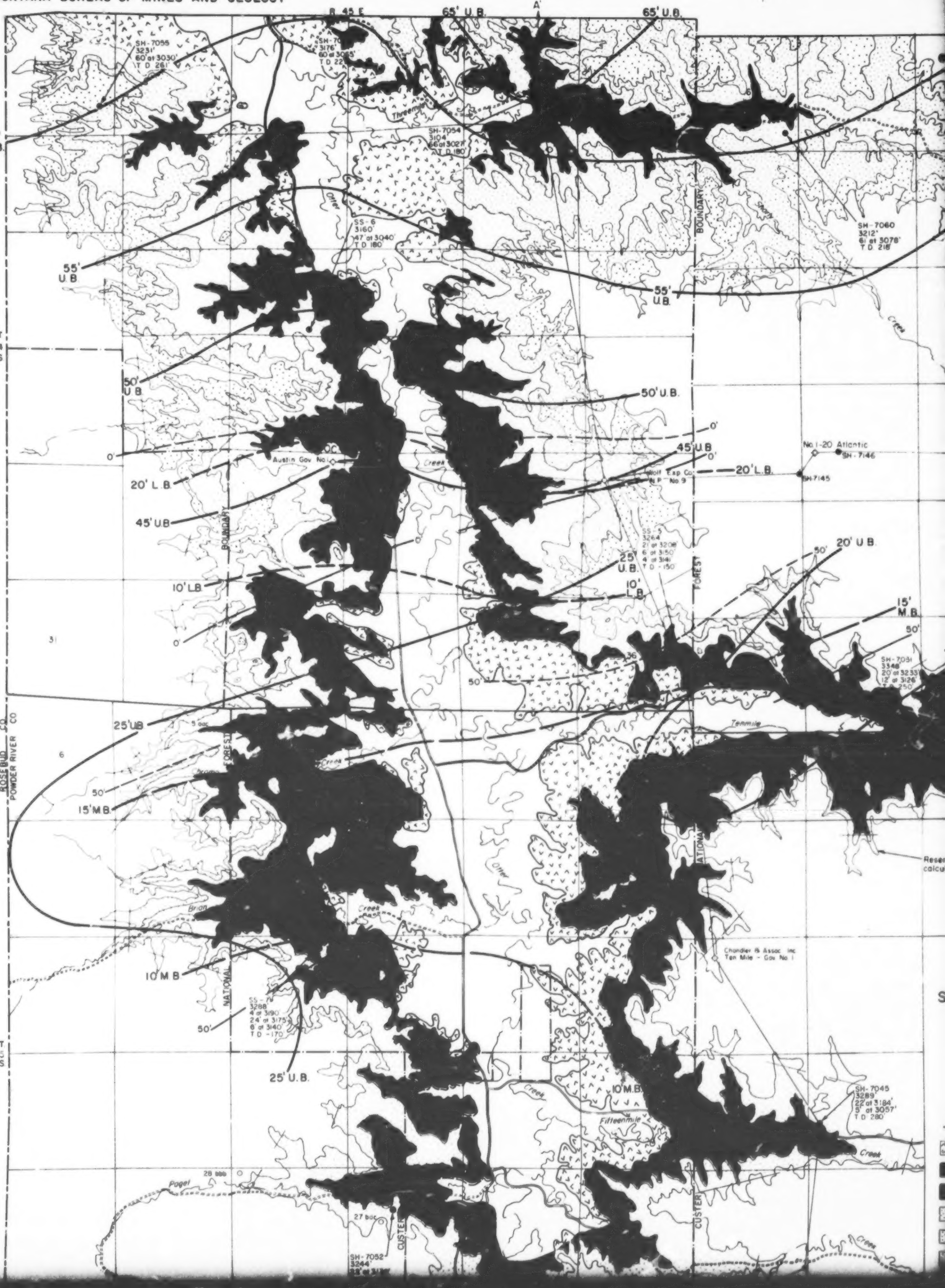

0
1/2
1
2 MILES
Datum is mean sea level
N
B.L.
R 44 E.
R 45 E.
R 43 E
R 44 E
T 3 S
T 4 S
BOUNDARY
RIVER
RESERVATION
INDIAN
CHEYENNE
TONGUE
NORTHERN
CUSTER
NATIONAL
FOREST
BOUNDARY
ROSEBUD CO.
POWDER RIVER CO.
Spring
Bowman
King
Dry
Creek
Otter Cr.
SH-7059
3228
14' at 3036'
T.D. 206'
SH-7058
3260
3' at 3200'
42' at 3072'
T.D. 250'
SH-7055
12 bae
1
6
Reserves not calculated
Knobloch coal bed splits and thins to south
40'
PO
EXPLANATION
Knobloch coal bed
Clinker
0-50' overburden
50'-100' overburden
100'-150' overburden
150'-200' overburden
200'-250' overburden
MBMG drill hole
SH-7059 hole designation
3228' altitude at top of collar
14' at 3036' altitude at top of 14' of coal
T.D. 206' total depth of hole
Water well drill hole
22abd
Parting information
40 Isopach of coal bed
PO B.L. Line of cross section (plate 34)

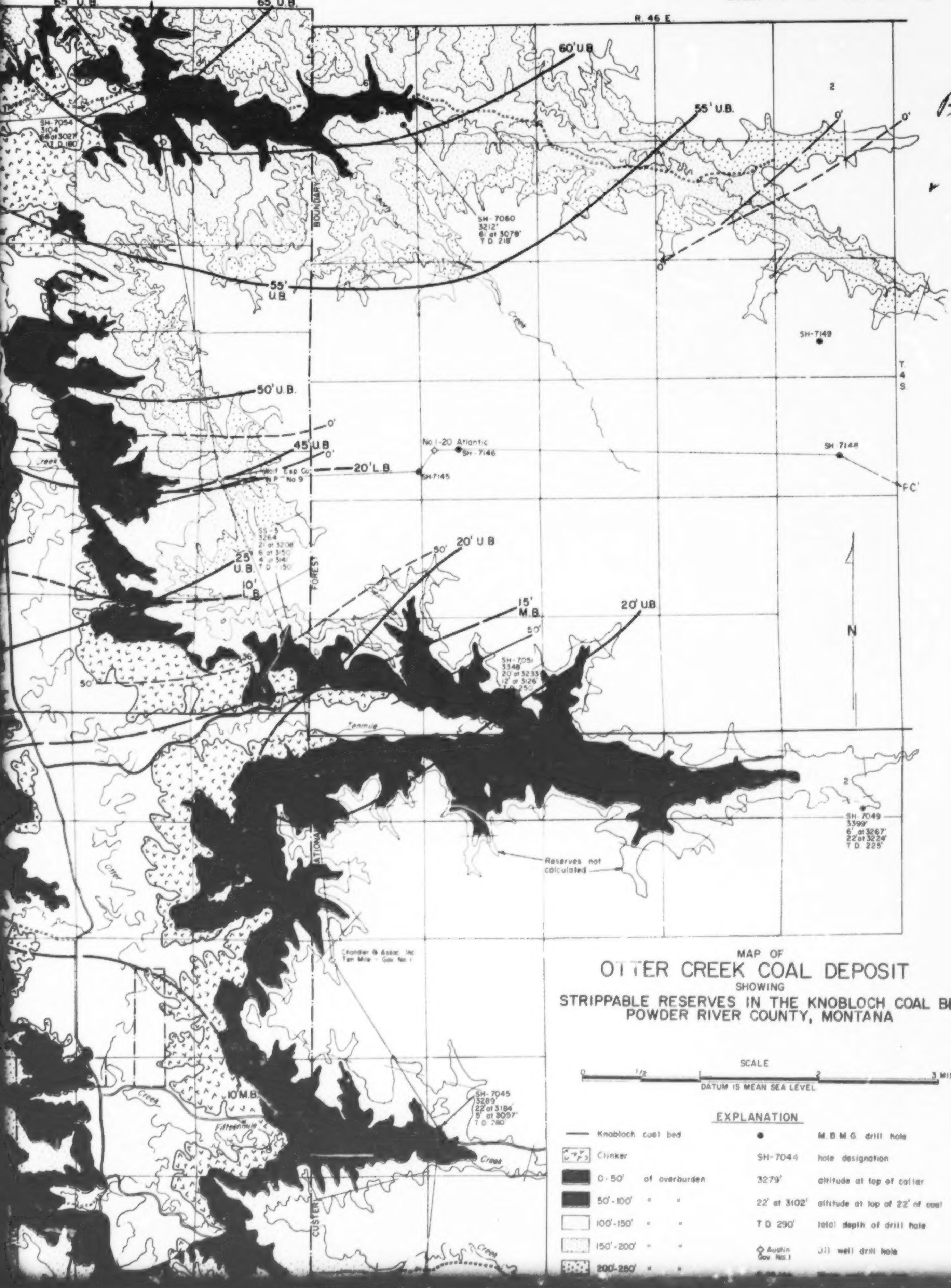
Base from advance topographic quadrangle maps Ashland, Green Creek, Willow Crossing, and King Mountain

Project Chief – R. E. Matson
Geologist – J. W. Blumer
Draftsman – E. A. Woods

MONTANA BUREAU OF MINES AND GEOLOGY

A


R. 45 E.
65' U.B.
A'
65' U.B.
60' U.B.
SH-7055
3231'
60' at 3030'
T.D. 261'
SH-70
3176'
60' at 3065'
T.D. 22
Threemile
SH-7054
3104'
66' at 3027'
T.D. 180'
Otter
SS-6
3160'
47' at 3040'
T.D. 180
55' U.B.
55' U.B.
BOUNDARY
SH-7060
3212'
61' at 3078'
T.D. 218'
Creek
T 4 S
50' U.B.
50' U.B.
0'
0'
Austin Gov. No. 1
Creek
45' U.B.
0'
20' L.B.
Wolf Exp. Co.
N.P. No. 9
20' L.B.
No. 1-20 Atlantic
SH-7146
SH-7145
45' U.B.
BOUNDARY
SS-5
3264
21' at 3208'
6' at 3150'
4' at 3141'
T.D. -150'
25' U.B.
10' L.B.
FOREST
20' U.B.
50'
10' L.B.
0'
15' M.B.
50'
31
36
50'
SH-7051
3348'
20' at 3233'
12' at 3126'
T.D. 250'
25' U.B.
5 bac
ROSEBUD CO.
POWDER RIVER CO.
6
FOREST
Tenmile
Creek
50'
15' M.B.
NATIONAL
Otter
Reser
calcu
Brian
Creek
10 M.B.
NATIONAL
Chandler & Assoc. Inc.
Ten Mile - Gov. No. 1
SS-7
3288'
4' at 3190'
24' at 3175'
6' at 3140'
T.D. -170'
50'
T 5 S
25' U.B.
Creek
10 M.B.
Fifteenmile
SH-7045
3289'
22' at 3184'
5' at 3057'
T.D. 280'
Creek
S
Pagel
28 bbb
27 bdc
CUSTER
CUSTER
SH-7052
3244'
Creek


65' U.B.
A'
65' U.B.
R. 46 E.
60' U.B.
55' U.B.
B
2
0'
0'
6
SH-7054
3104
66 at 3027'
T.D. 180'
Threemile
SH-7060
3212'
6' at 3078'
T.D. 218'
BOUNDARY
55'
U.B.
Creek
SH-7149
T.
4
S.
50' U.B.
0'
45' U.B.
0'
No 1-20 Atlantic
SH-7146
20' L.B.
SH-7145
Wolf Exp Co.
N.P. No 9
SH-7148
FC'
SS-5
3264
21' at 3208
6' at 3150
4' at 3141
T.D. 150'
25'
U.B.
10'
L.B.
FOREST
20' U.B.
50'
15'
M.B.
20' U.B.
50'
N
SH-7051
3348'
20' at 3233'
12' at 3126'
T.D. 250'
36
50'
Tenmile
2
SH-7049
3399'
6' at 3267'
22' at 3224'
T.D. 225'
Reserves not calculated
NATIONAL
Otter
Chandler & Assoc. Inc
Ten Mile - Gov No 1
CUSTER
10' M.B.
SH-7045
3289'
22' at 3184'
5' at 3057'
T.D. 280'
Creek
Fifteenmile
Creek
Creek

MAP OF
OTTER CREEK COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED, POWDER RIVER COUNTY, MONTANA

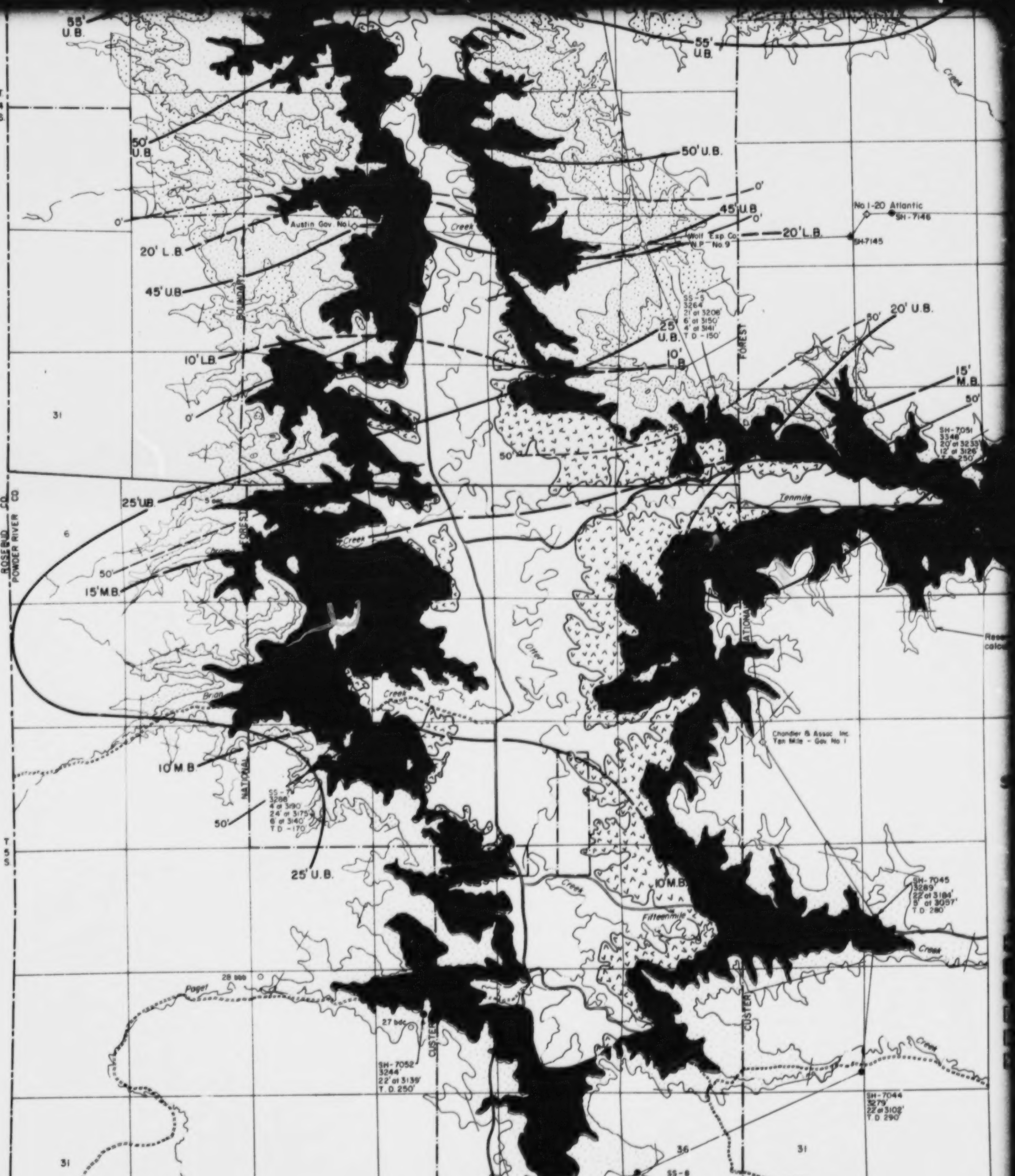
SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

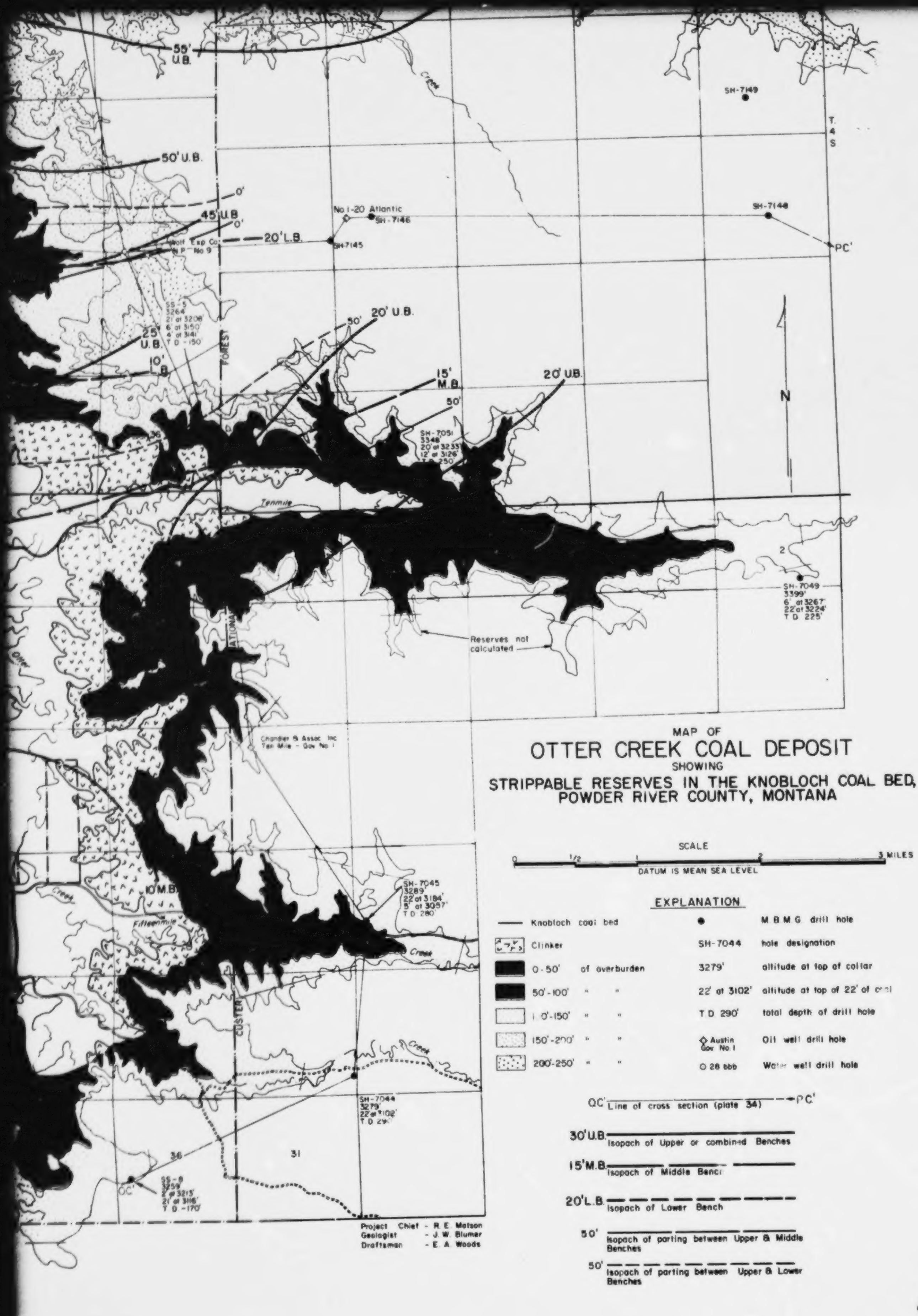
EXPLANATION

—	Knobloch coal bed	●	M.B.M.G. drill hole
▨	Clinker	SH-7044	hole designation
■	0-50' of overburden	3279'	altitude at top of collar
■	50'-100' " "	22' at 3102'	altitude at top of 22' of coal
☐	100'-150' " "	T.D. 290'	total depth of drill hole
▨	150'-200' " "	◇ Austin Gov. No. 1	Oil well drill hole
▨	200'-250' " "		


55' U.B.
55' U.B.
T 4 S.
50' U.B.
50' U.B.
0'
0'
Austin Gov No 1
Creek
20' L.B.
45' U.B.
45' U.B.
0'
Wolf Exp Co.
N.P. No 9
20' L.B.
No 1-20 Atlantic
SH-7146
SH-7145
BOUNDARY
SS-5
3264
21 at 3208'
6' at 3150'
4' at 3141'
T D - 150'
FOREST
0'
25 U.B.
10' L.B.
10' L.B.
50'
20' U.B.
15' M.B.
50'
0'
31
36
50'
SH-7051
3348'
20' at 3233'
12' at 3126'
T.D. 250'
25' U.B.
ROSEBUD CO.
POWDER RIVER CO.
6
FOREST
Creek
Tenmile
NATIONAL
50'
15' M.B.
Otter
Brian
Creek
Chandler & Assoc. Inc.
Ten Mile - Gov No 1
10 M.B.
NATIONAL
SS-7
3288'
4' at 3190'
24' at 3175'
6' at 3140'
T.D. -170'
50'
T 5 S
25' U.B.
Creek
10 M.B.
Fifteenmile
SH-7045
3289'
27' at 3184'
5' at 3057'
T.D. 280'
Creek
28 bbb
Pagel
27 bdc
CUSTER
CUSTER
SH-7052
3244'
22' at 3139'
T.D. 250'
Creek
SH-7044
3279'
22' at 3102'
T.D. 290'
31
36
31
SS-8
3259'
2' at 3213'
21' at 3116'
T.D. -170'
OC'
R. 45 E.

Base map from U.S.G.S. 7 1/2 minute topographic maps:
King Mtn., Yager Butte, Ft Howes, and Goodspeed Butte.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods



55' U.B.
Creek
SH-7149
T. 4 S.
50' U.B.
0'
45' U.B.
0'
No. 1-20 Atlantic
SH-7146
SH-7148
Wolf Exp Co. N.P. No 9
20' L.B.
SH7145
PC'
SS-5
3264
21' at 3208'
6' at 3150'
4' at 3141'
T.D. -150'
25' U.B.
10' L.B.
50'
20' U.B.
FOREST
15' M.B.
50'
20' U.B.
N
SH-7051
3348'
20' at 3233'
12' at 3126'
T.D. 250'
36
Tenmile
2
SH-7049
3399'
6' at 3267'
22' at 3224'
T.D. 225'
NATIONAL
Reserves not calculated
Otter
Chandler & Assoc. Inc
Ten Mile - Gov No. 1
10' M.B.
Creek
Fifteenmile
SH-7045
3289'
22' at 3184'
5' at 3057'
T.D. 280'
Creek
CUSTER
Creek
SH-7044
3279'
22' at 3102'
T.D. 290'
31
36
QC'
SS-8
3259'
2' at 3215'
21' at 3116'
T.D. -170'
SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL
EXPLANATION
Knobloch coal bed
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
200'-250' " "
● M.B.M.G. drill hole
SH-7044 hole designation
3279' altitude at top of collar
22' at 3102' altitude at top of 22' of coal
T.D. 290' total depth of drill hole
Austin Gov No. 1 Oil well drill hole
○ 28 bbb Water well drill hole
QC' Line of cross section (plate 34) PC'
30' U.B. Isopach of Upper or combined Benches
15' M.B. Isopach of Middle Bench
20' L.B. Isopach of Lower Bench
50' Isopach of parting between Upper & Middle Benches
50' Isopach of parting between Upper & Lower Benches

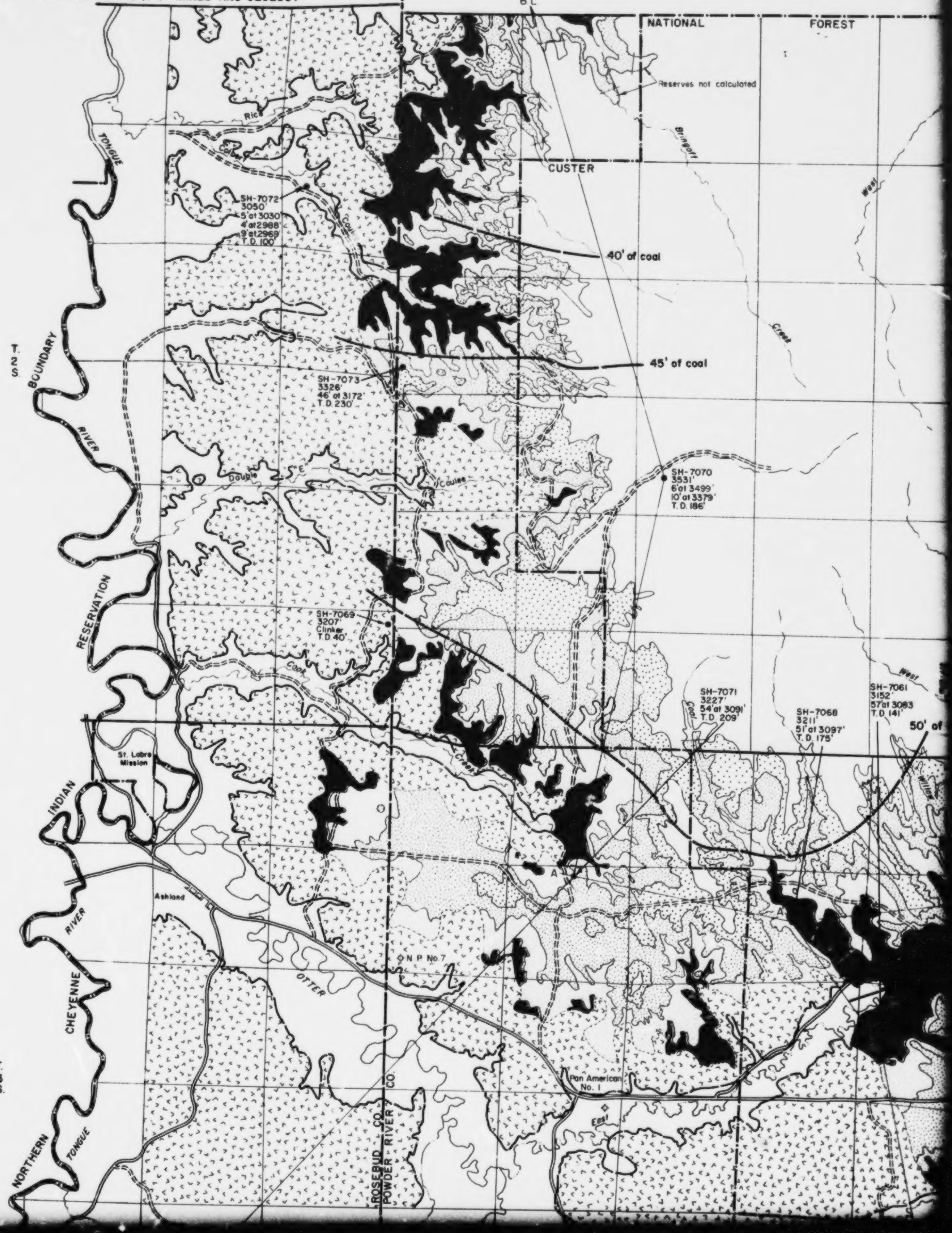
MAP OF
OTTER CREEK COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED,
POWDER RIVER COUNTY, MONTANA

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

D

A

MONTANA BUREAU OF MINES AND GEOLOGY



B L
NATIONAL
FOREST
CUSTER
Reserves not calculated
Rice
Coal
Coulee
Bringoff
West
Creek
SH-7072
3050'
5' at 3030'
4' at 2988'
9' at 2969'
T.D. 100'
40' of coal
45' of coal
SH-7073
3326'
46' at 3172'
T.D. 230'
TONGUE
T. 2 S.
BOUNDARY
RIVER
RESERVATION
INDIAN
CHEYENNE
NORTHERN
TONGUE
RIVER
T. 3 S.
Double
Coulee
SH-7070
3531'
6' at 3499'
10' at 3379'
T.D. 186'
SH-7069
3207'
Clinker
T.D. 40'
Cook
Creek
SH-7071
3227'
54' at 3091'
T.D. 209'
SH-7068
3211'
51' at 3097'
T.D. 175'
SH-7061
3152'
57' at 3083
T.D. 141'
50' of
Willow
St. Labre Mission
Ashland
A
A
N P No 7
OTTER
Pan American No. 1
East
ROSEBUD CO
POWDER RIVER CO

BULLETIN 91 PLATE 13 A

B

MAP OF

ASHLAND COAL DEPOSIT

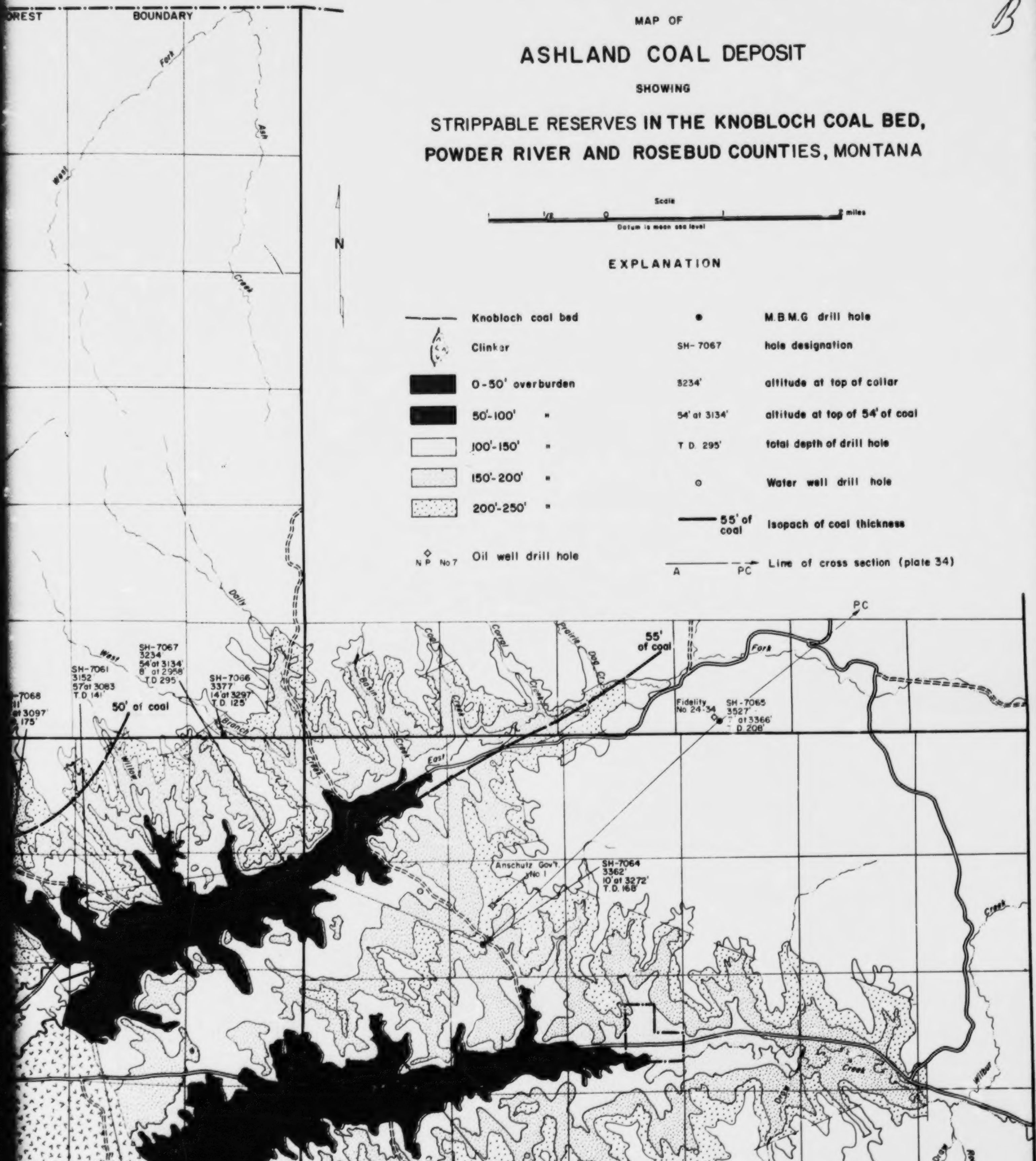
SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED, POWDER RIVER AND ROSEBUD COUNTIES, MONTANA

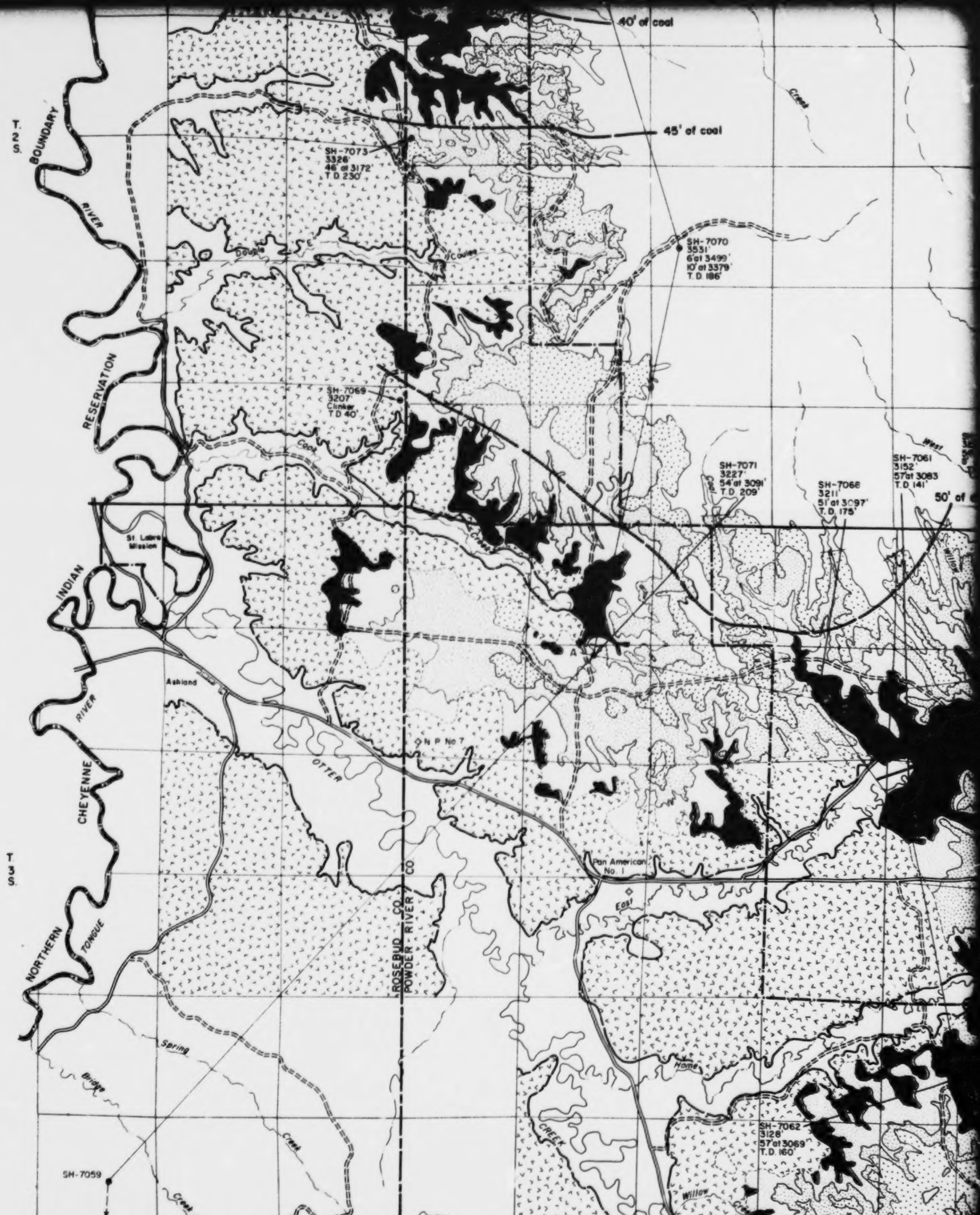
Scale
1 1/2 0 1 2 miles
Datum is mean sea level

EXPLANATION

— — —	Knobloch coal bed	●	M.B.M.G drill hole
	Clinker	SH-7067	hole designation
■	0-50' overburden	3234'	altitude at top of collar
■	50'-100' "	54' at 3134'	altitude at top of 54' of coal
☐	100'-150' "	T.D. 295'	total depth of drill hole
☐	150'-200' "	○	Water well drill hole
▨	200'-250' "	—— 55' of coal	Isopach of coal thickness
◇ N P No 7	Oil well drill hole	A —— PC →	Line of cross section (plate 34)

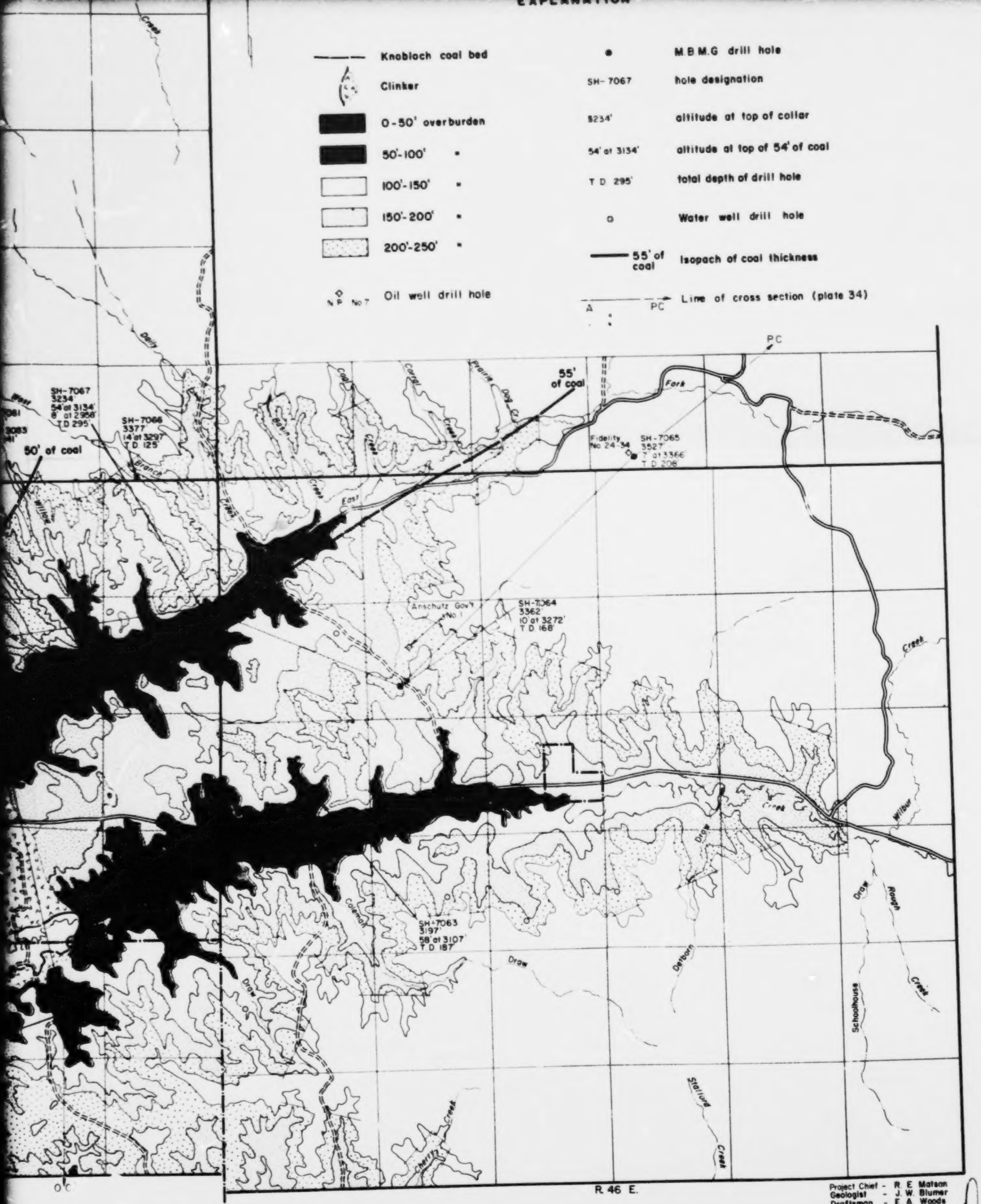


FOREST BOUNDARY
N
West Fork Ash Creek
Daily
West Branch
Willow
SH-7068
3097'
175'
SH-7061
3152'
57' at 3083'
T.D 141'
SH-7067
3234'
54' at 3134'
8' at 2958'
T.D 295'
SH-7066
3377'
14' at 3297'
T.D 125'
50' of coal
55' of coal
Basin Creek
Coal Creek
Corral Creek
Prairie Dog Cr.
East Fork
PC
Fidelity No 24-34
SH-7065
3527'
at 3366'
T.D 208'
Anschutz Gov't. No 1
SH-7064
3362'
10' at 3272'
T.D. 168'
Creek
Wilbur
Draw
Coleman
SH-7063
3197'
58' at 3107'
T.D. 187'


40' of coal
45' of coal
50' of c
T. 2 S.
T. 3 S.
NORTHERN CHEYENNE INDIAN RESERVATION BOUNDARY
TONGUE RIVER
OTTER
Creek
Cook
Coulee
St. Labre Mission
Ashland
N P No 7
Pan American No. 1
East
Home
Willow
CREEK
Spring
Bridge
West
ROSEBUD CO.
POWDER RIVER CO.
SH-7073
3326'
46' at 3172'
T.D 230'
SH-7070
3531'
6' at 3499'
10' at 3379'
T.D 186'
SH-7069
3207'
Clinker
T.D 40'
SH-7071
3227'
54' at 3091'
T.D 209'
SH-7068
3211'
51' at 3097'
T.D 175'
SH-7061
3152'
57' at 3083
T.D 141'
SH-7062
3128'
57' at 3069'
T.D 160'
SH-7059
P.O.
R. 44 E.
R. 45 E.
O C.

Base map from U.S.G.S. (7 1/2 min. series) advance topographic quadrangle maps: Ashland, Ashland N.E., Cook Cr. Res., Willow Crossing.

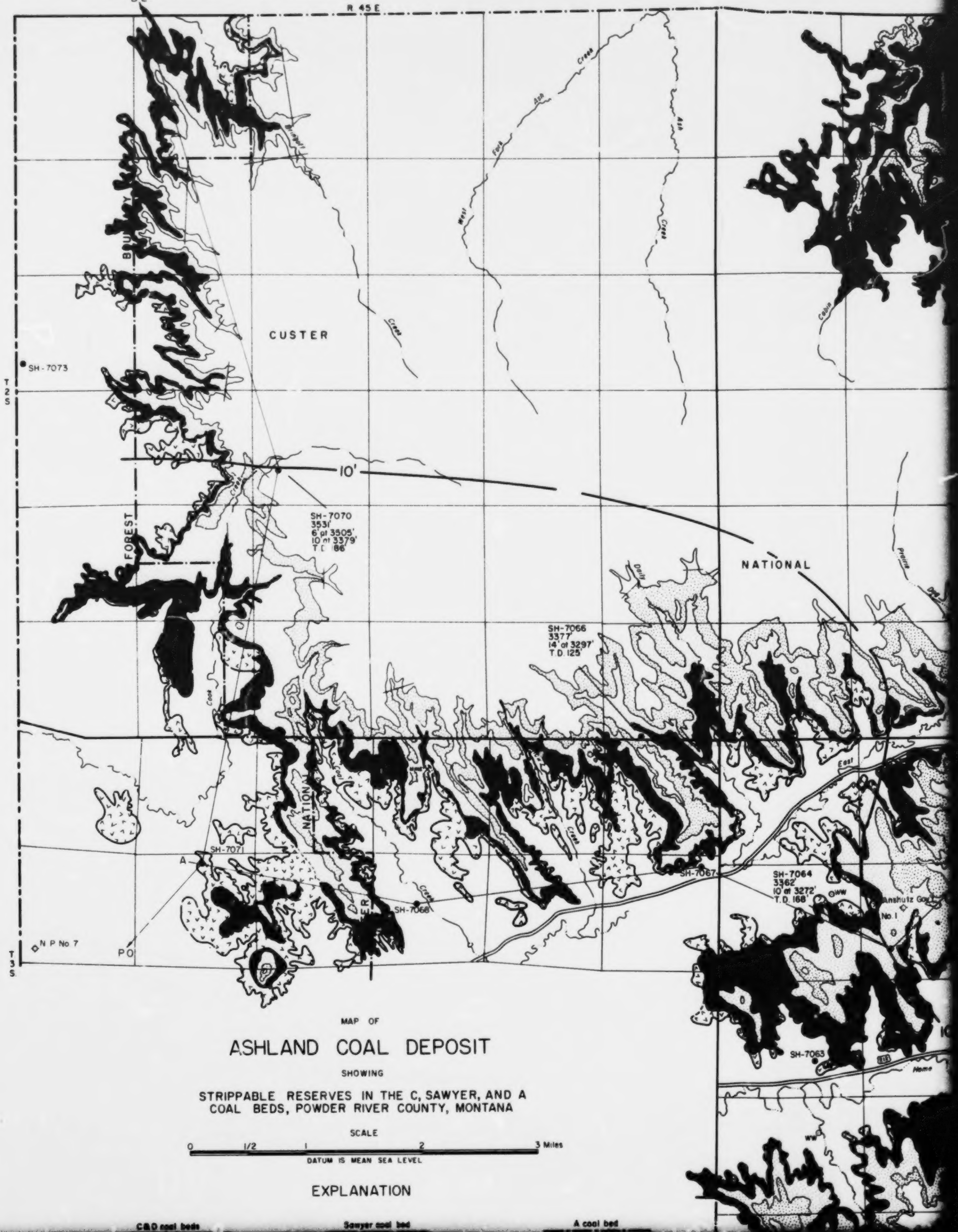
EXPLANATION



Knobloch coal bed
Clinker
0-50' overburden
50'-100' "
100'-150' "
150'-200' "
200'-250' "
N P No 7
Oil well drill hole
M.B.M.G drill hole
SH-7067 hole designation
3234' altitude at top of collar
54' at 3134' altitude at top of 54' of coal
T D 295' total depth of drill hole
Water well drill hole
55' of coal Isopach of coal thickness
A PC Line of cross section (plate 34)
PC
55' of coal
50' of coal
SH-7067
3234'
54' at 3134'
8' at 2958'
T D 295'
SH-7066
3377'
14' at 3297
T D 125'
Fidelity No 24-34
SH-7065
3527'
7' at 3366'
T D 208'
Anschutz Gov't No 1
SH-7064
3362'
10' at 3272'
T D 168'
SH-7063
3197'
58' at 3107'
T D 187'
Creek
Dally
West
Willow
Branch
Basin
Coal
Corral
Creek
Prairie Dog Cr
East
Fork
Creek
Creek
Wilbur
Draw
Coleman
Draw
Draw
Dethorn
Draw
Rough
Creek
Schoolhouse
Stafford
Creek
Cherry
Creek
O C
R 46 E.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

A MONTANA BUREAU OF MINES AND GEOLOGY


B L
R 45 E
Ash Creek
West Fork Ash Creek
Creek
Cabin
CUSTER
SH-7073
T 2 S
10'
FOREST
BOUNDARY
SH-7070
3531'
6' at 3505'
10' at 3379'
T.D. 186'
NATIONAL
Prairie
SH-7066
3377'
14' at 3297'
T.D. 125'
Coal
NATIONAL
East
SH-7071
A
SH-7067
SH-7064
3362'
10' at 3272'
T.D. 168'
WW
Anshutz Go
No. 1
SH-7068
Creek
N P No 7
P O
T 3 S
SH-7063
Home
WW

MAP OF

ASHLAND COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE C, SAWYER, AND A
COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 Miles

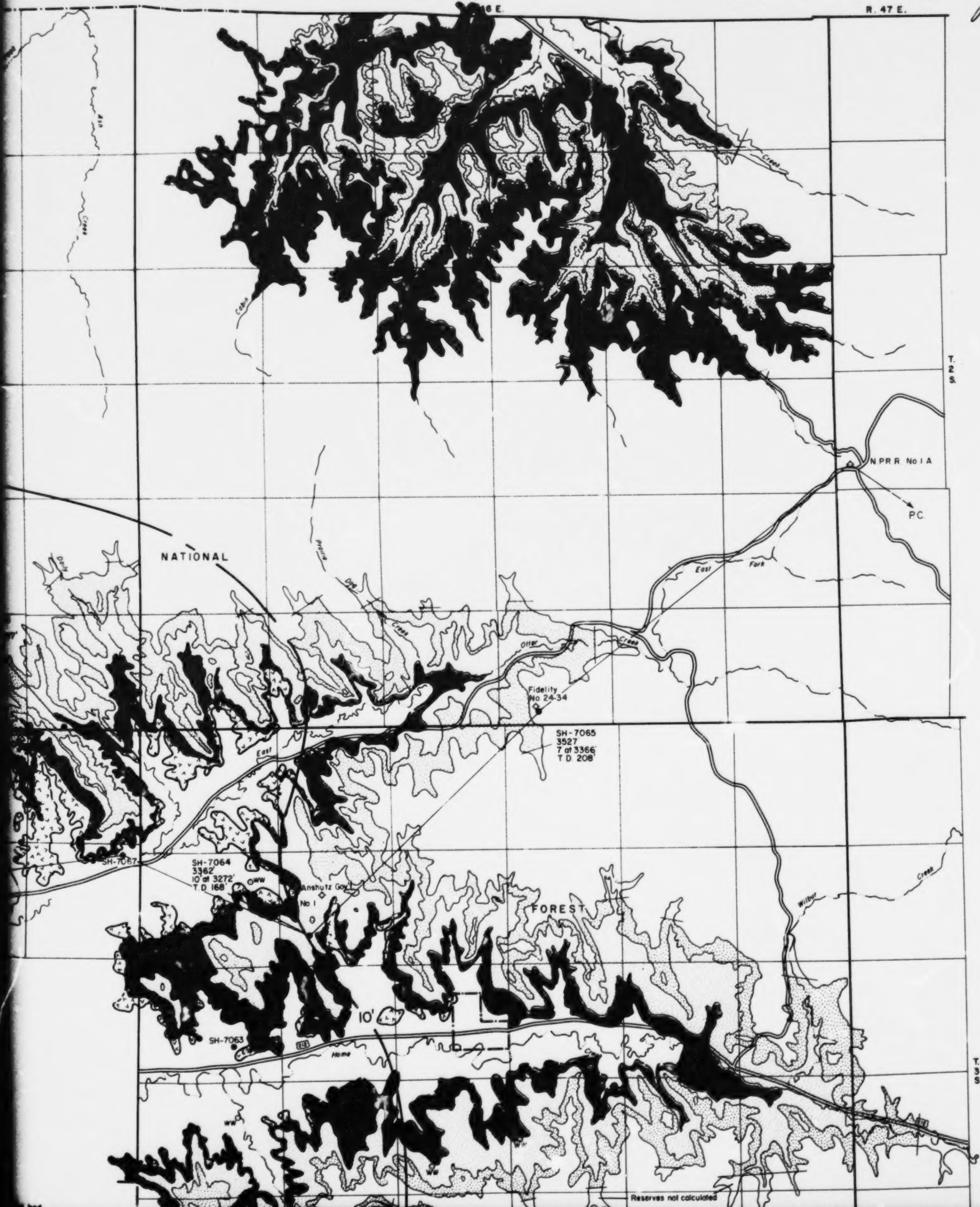
DATUM IS MEAN SEA LEVEL

EXPLANATION

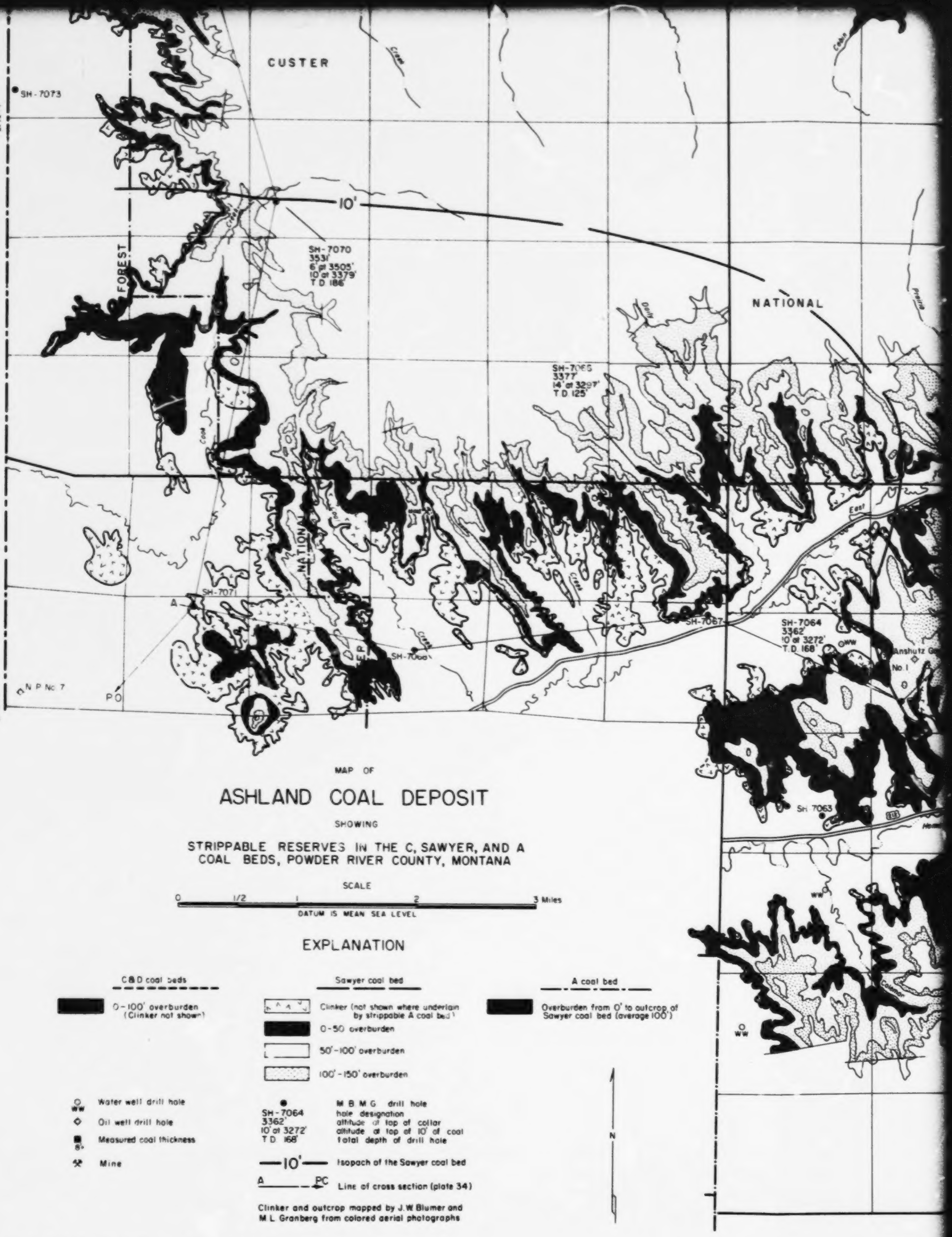
C&D coal beds Sawyer coal bed A coal bed

BULLETIN 91 PLATE 13B

B



6 E.
R. 47 E.
Ash
Creek
Cabin
Dead
Creek
Creek
Creek
T. 2 S.
N.P.R.R. No 1 A
P.C.
Dolly
NATIONAL
Prairie
Dog
Creek
East
Fork
Otter
Creek
Fidelity
No 24-34
SH-7065
3527
7' of 3366'
T.D. 208'
East
SH-7067
SH-7064
3362'
10' of 3272'
T.D. 168'
WW
Anshutz Gov't
No 1
FOREST
Wilbur
Creek
10'
SH-7063
Home
WW
WW
T. 3 S.
Reserves not calculated
Draw


CUSTER
NATIONAL
FOREST
NATIONAL
SH-7073
T 2 S
T 3 S
10'
SH-7070
3531'
6' at 3505'
10' at 3379'
T.D. 186'
SH-7066
3377'
14' at 3297'
T.D. 125'
SH-7071
A
SH-7068
N.P. No. 7
PC
SH-7067
SH-7064
3362'
10' at 3272'
T.D. 168'
Anshutz
No. 1
SH-7063
WW
Creek
Coal
East
Prairie
Coleman

MAP OF

ASHLAND COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE C, SAWYER, AND A
COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 Miles

DATUM IS MEAN SEA LEVEL

EXPLANATION

C&D coal beds

■ 0-100' overburden (Clinker not shown)

Sawyer coal bed

▨ Clinker (not shown where underlain by strippable A coal bed)

■ 0-50 overburden

☐ 50'-100' overburden

▨ 100'-150' overburden

A coal bed

■ Overburden from 0' to outcrop of Sawyer coal bed (average 100')

○ WW Water well drill hole

◇ Oil well drill hole

■ 8' Measured coal thickness

⚒ Mine

● M.B.M.G. drill hole

SH-7064	hole designation
3362'	altitude of top of collar
10' at 3272'	altitude at top of 10' of coal
T.D. 168'	total depth of drill hole

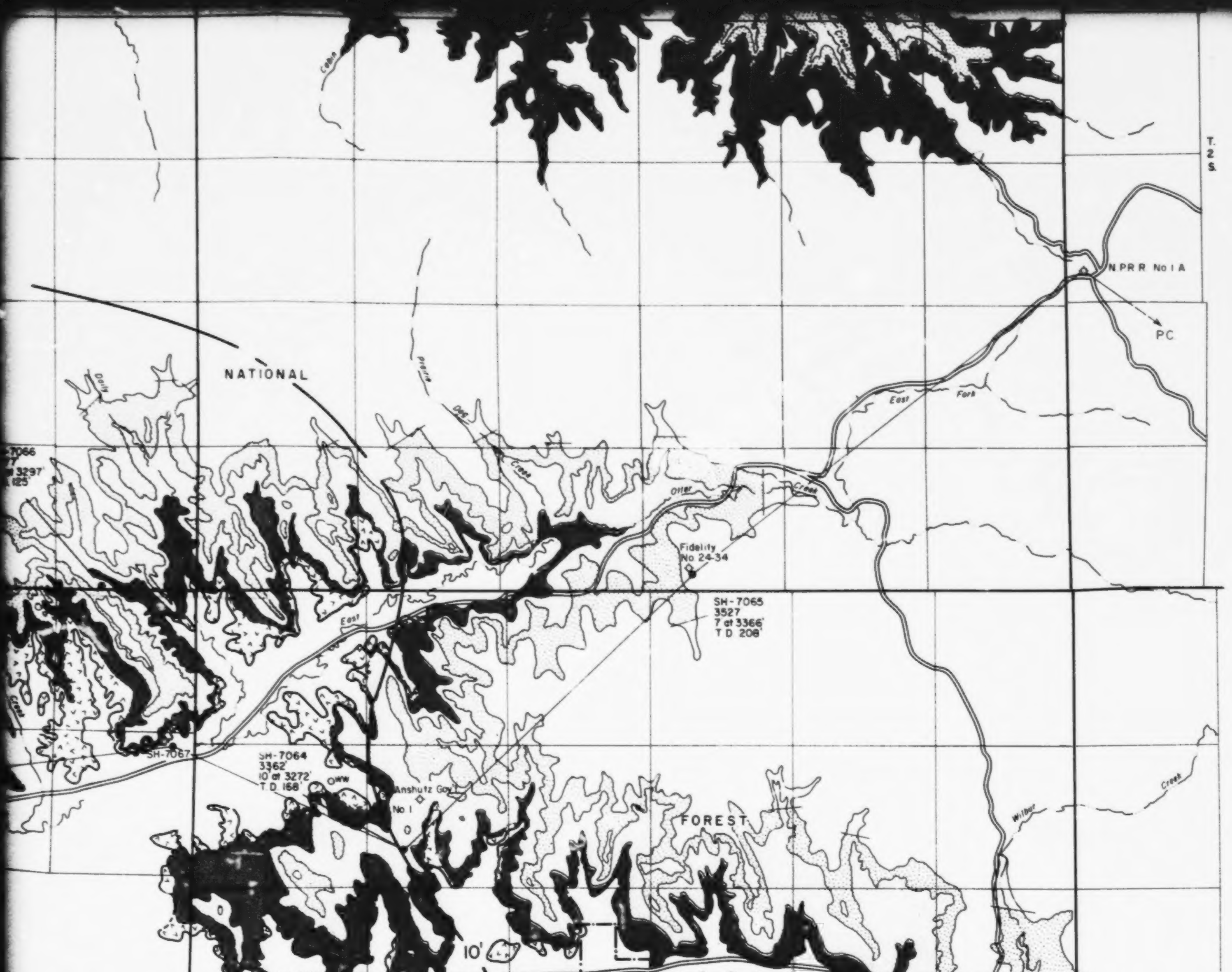
—10'— Isopach of the Sawyer coal bed

A——PC Line of cross section (plate 34)

Clinker and outcrop mapped by J.W. Blumer and M.L. Granberg from colored aerial photographs

N

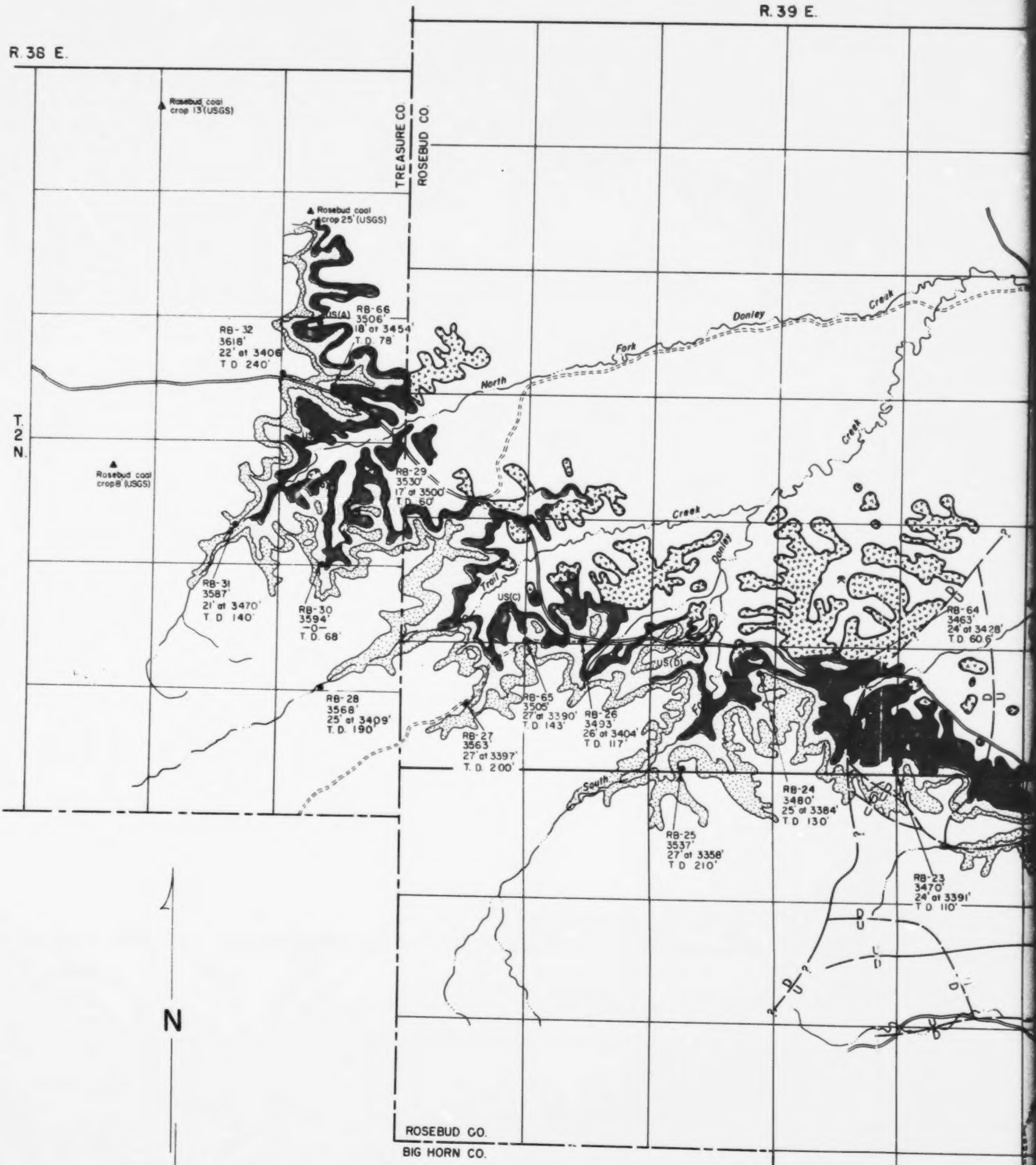
Base map from U.S.G.S. 7 1/2 minute topographic maps:
Coleman Draw, Home Creek Butte, Yoger Butte, Threemile Buttes.


T. 2 S.
Cabin
Prairie Dog Creek
NPRR No 1 A
PC
NATIONAL
East Fork
Otter Creek
Fidelity No 24-34
SH-7065 3527 7' at 3366' T D 208'
-7066
7
at 3297'
125'
East
SH-7067
SH-7064 3362' 10' at 3272' T D 168'
WW
Anshutz Gay No 1
FOREST
Wilbur Creek
10'
SH-7063
212
Home Creek
T. 3 S.
WW
Coleman Draw
Reserves not calculated
A coal bed
den from 0' to outcrop of coal bed (average 100')
N
R. 46 E.
R. 47 E.
Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - M. J. Daniels

D

A

MONTANA BUREAU OF MINES AND GEOLOGY

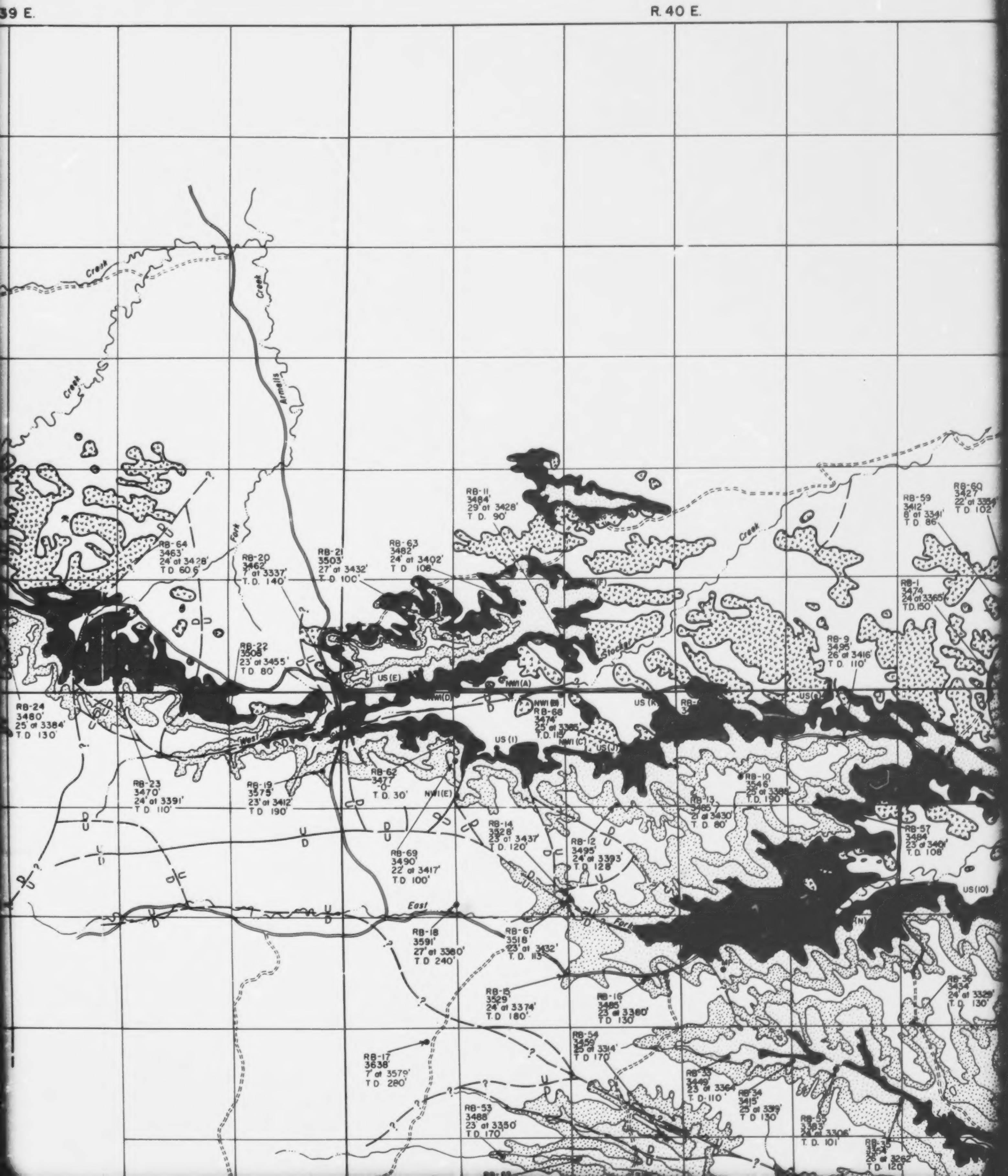


R. 39 E.
R. 38 E.
Rosebud coal crop 13'(USGS)
TREASURE CO.
ROSEBUD CO.
Rosebud coal crop 25' (USGS)
US(A)
RB-66 3506' 18' at 3454' T.D. 78'
RB-32 3618' 22' at 3406' T.D. 240'
North
Fork
Donley
Creek
T. 2 N.
Rosebud coal crop 8' (USGS)
Creek
RB-29 3530' 17' at 3500' T.D. 60'
Creek
Donley
Trail
US(C)
RB-31 3587' 21' at 3470' T.D. 140'
RB-30 3594' -0- T.D. 68'
US(D)
Fork
RB-64 3463' 24' at 3428' T.D. 60.6'
RB-28 3568' 25' at 3409' T.D. 190'
RB-65 3505' 27' at 3390' T.D. 143'
RB-26 3493' 26' at 3404' T.D. 117'
RB-27 3563' 27' at 3397' T.D. 200'
South
RB-24 3480' 25' at 3384' T.D. 130'
RB-25 3537' 27' at 3358' T.D. 210'
RB-23 3470' 24' at 3391' T.D. 110'
D
U
N
ROSEBUD CO.
BIG HORN CO.

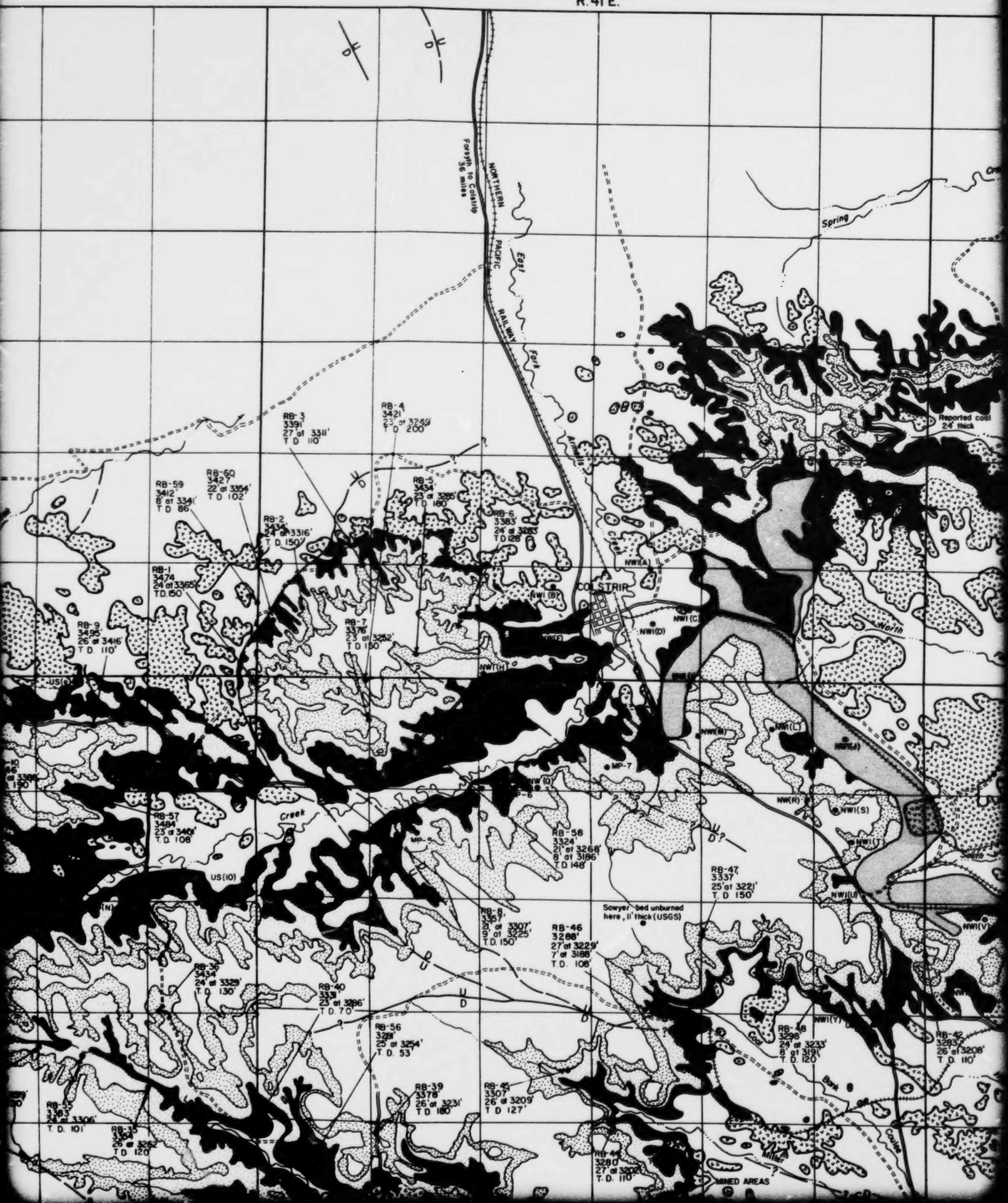
MAP OF

COLSTRIP COAL DEPOSIT

B


39 E.
R. 40 E.
Creek
Creek
Creek
Armells
Fork
Creek
Slocks
West
East
Fork
RB-11
3484'
29' at 3428'
T.D. 90'
RB-59
3412'
8' at 3341'
T.D. 86'
RB-60
3427
22' at 3354'
T.D. 102'
RB-64
3463'
24' at 3428'
T.D. 60.6'
RB-20
3462'
7' at 3337'
T.D. 140'
RB-21
3503'
27' at 3432'
T.D. 100'
RB-63
3482'
24' at 3402'
T.D. 108
RB-1
3474
24' at 3365'
T.D. 150
RB-9
3495'
26' at 3416'
T.D. 110'
RB-22
3508'
23' at 3455'
T.D. 80'
RB-24
3480'
25' at 3384'
T.D. 130'
US(E)
NWI(A)
NWI(D)
NWI(B)
RB-68
3474'
US(K)
US(I)
NWI(C)
US(J)
RB-23
3470'
24' at 3391'
T.D. 110'
RB-19
3575'
23' at 3412'
T.D. 190'
RB-62
3477'
-0-
T.D. 30'
NWI(E)
RB-10
3546
25' at 3386'
T.D. 190'
RB-13
21' at 3430'
T.D. 80'
RB-14
3528'
23' at 3437'
T.D. 120'
RB-12
3495'
24' at 3393'
T.D. 128'
RB-57
3484
23' at 3401'
T.D. 108'
RB-69
3490'
22' at 3417'
T.D. 100'
US(10)
RB-18
3591'
27' at 3380'
T.D. 240'
RB-67
3518'
23' at 3432'
T.D. 113'
(N)
RB-15
3529
24' at 3374'
T.D. 180'
RB-16
3485'
23' at 3360'
T.D. 130'
RB-36
3434
24' at 3329'
T.D. 130'
RB-17
3638'
7' at 3579'
T.D. 280'
RB-54
3459
25' at 3314'
T.D. 170'
RB-33
3449
23' at 3364'
T.D. 110'
RB-34
3415'
25' at 3319'
T.D. 130
RB-53
3488'
23' at 3350'
T.D. 170'
3306'
T.D. 101'
26' at 3262'
T.D. 120'
U
D
?

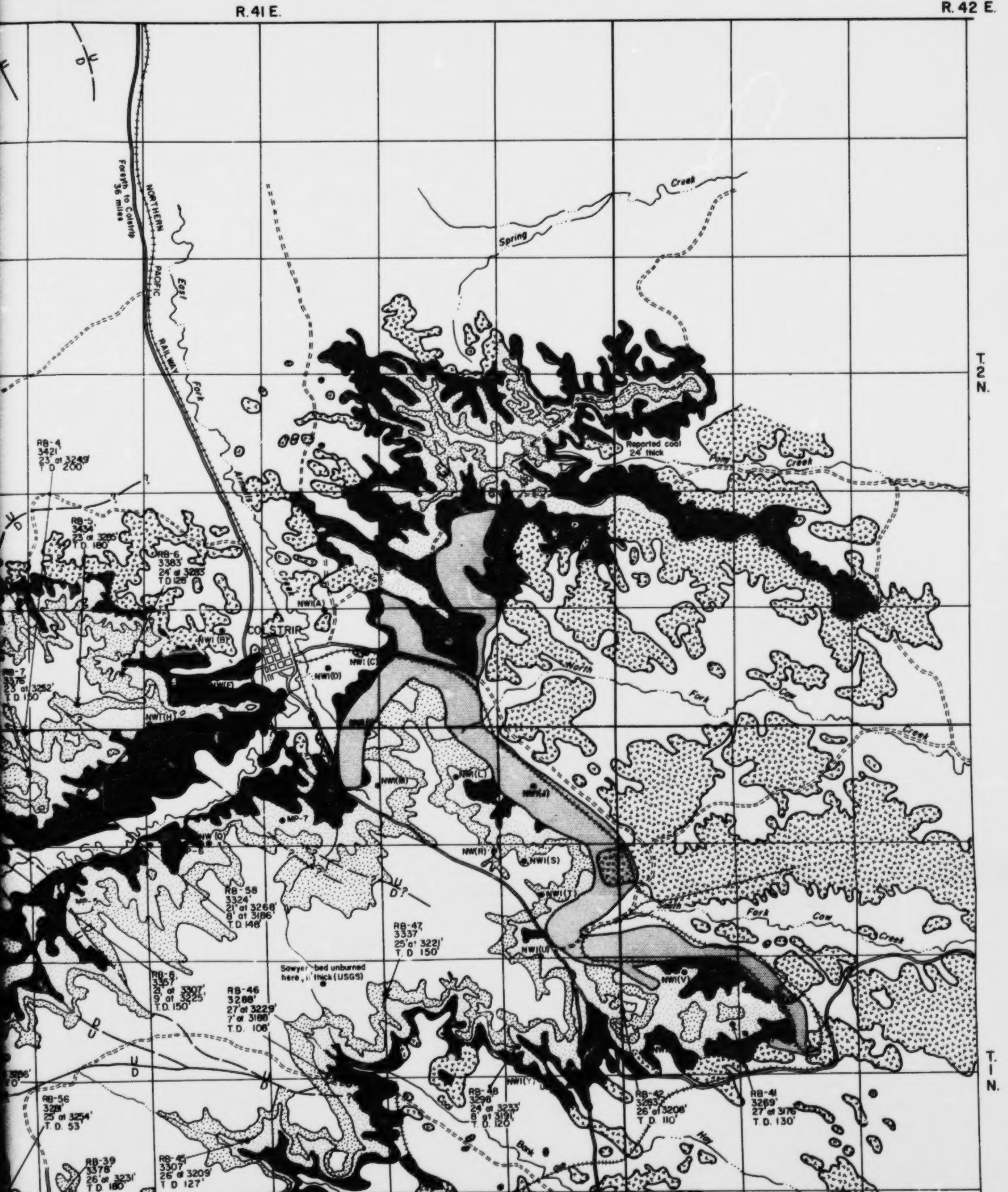
C

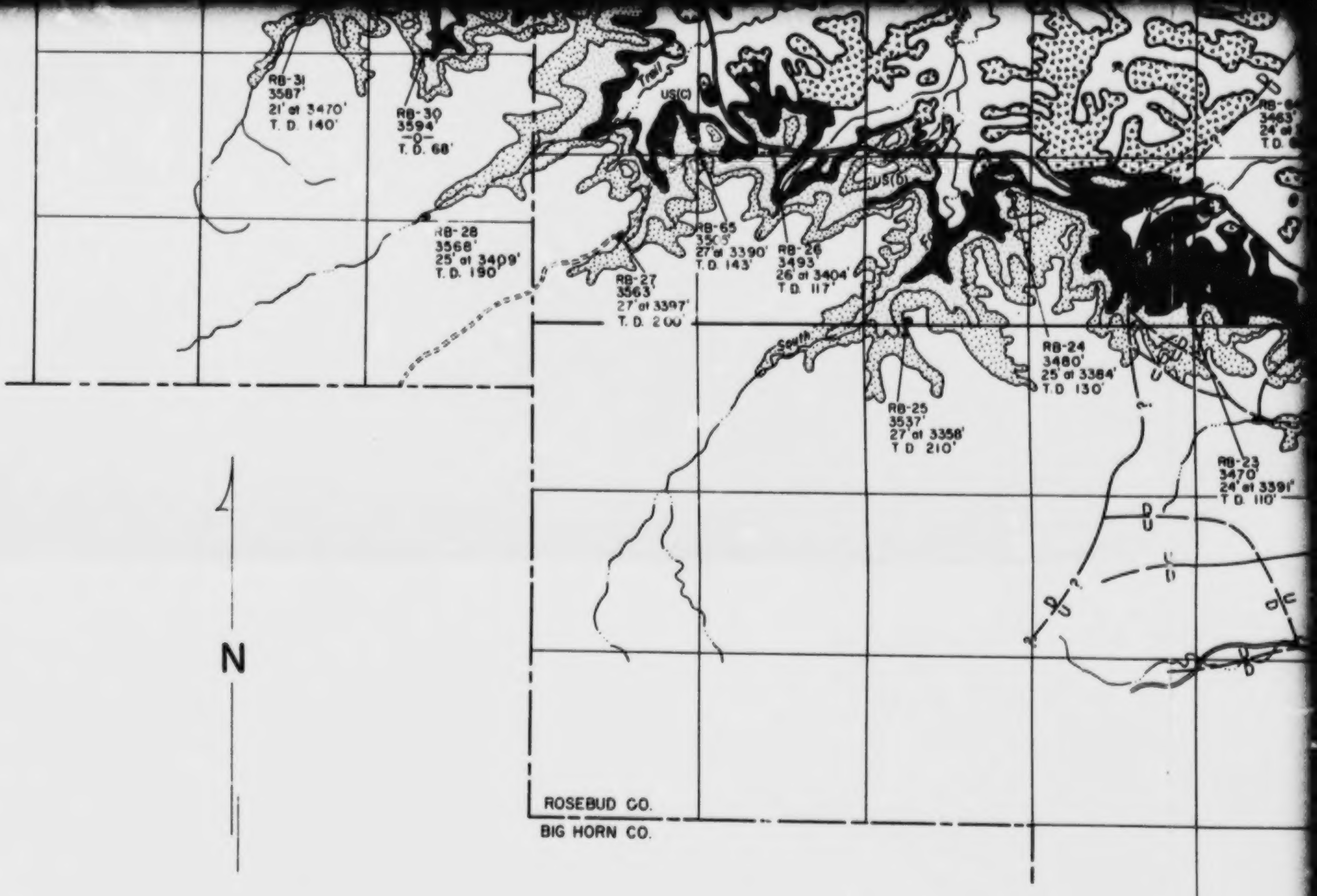

R. 41 E.
Forsyth to Colstrip 36 miles
NORTHERN PACIFIC RAILWAY
East Fork
Armells
Spring
Reported coal 24' thick
COLSTRIP
NWI(A)
NWI(B)
NWI(C)
NWI(D)
NWI(E)
NWI(H)
NWI(L)
NWI(M)
NWI(J)
NWI(Q)
NW(R)
NWI(S)
NWI(T)
NWI(U)
NWI(V)
NWI(Y)
MP-7
MP-6
MP-5
North
South
Creek
US(10)
U
D
U
D?
RB-3
3391
27' at 3311'
T D 110'
RB-4
3421
23' at 3249'
T D 200'
RB-60
3427
22' at 3354'
T D 102'
RB-59
3412
8' at 3341'
T D 86
RB-2
3434
24' at 3316'
T D 150'
RB-5
3434
23' at 3285'
T D 160
RB-6
3383'
24' at 3283'
T D 128'
RB-1
3474
24' at 3365'
T.D. 150
RB-9
3495
26' at 3416'
T D 110'
RB-7
3376
23' at 3252'
T D 150
RB-57
3484
23' at 3401'
T.D. 108
RB-58
3324'
21' at 3268'
8' at 3186'
T.D. 148'
RB-47
3337
25' at 3221'
T D 150'
RB-8
3357'
21' at 3307'
9' at 3225'
T.D. 150'
Sawyer bed unburned here, 11' thick (USGS)
RB-46
3288'
27' at 3229'
7' at 3188'
T.D. 106'
RB-36
3434
24' at 3329'
T.D. 130'
RB-40
3331
23' at 3286'
T.D. 70'
RB-56
3281'
25' at 3254'
T.D. 53'
RB-48
3298
24' at 3233'
8' at 3191'
T.D. 120'
RB-42
3283'
26' at 3208'
T.D. 110'
RB-39
3378'
26' at 3231'
T D 180'
RB-45
3307
26' at 3209'
T D 127'
RB-55
3363
24' at 3306'
T.D. 101
RB-35
3364
26' at 3262
T D 120'
RB-44
3280
27' at 3202'
T.D. 110'
MINED AREAS
Cow
Bank
Miller
Coulee

C

BULLETIN 91 PLATE 14

D


R. 41 E.
R. 42 E.
T. 2 N.
T. 1 N.
NORTHERN PACIFIC RAILWAY
Forsyth to Colstrip 36 miles
East Fork
Armells Creek
Spring Creek
Reported coal 24' thick
Pony Creek
North Fork Cow Creek
South Fork Cow Creek
COLSTRIP
NWI(A)
NWI(B)
NWI(C)
NWI(D)
NWI(F)
NWI(H)
NWI(L)
NWI(J)
NW(R)
NWI(S)
NWI(T)
NWI(U)
NWI(V)
NWI(Y)
MP-7
MP-5
RB-4 3421 23' at 3249' T.D. 200
RB-5 3434 23' at 3285' T.D. 180
RB-6 3383' 24' at 3283 T.D. 128
RB-7 3376 23' at 3252' T.D. 150
RB-58 3324' 21' at 3268' 8' at 3186 T.D. 148
RB-47 3337 25' at 3221' T.D. 150'
Sawyer bed unburned here, 11' thick (USGS)
RB-8 3357 21' at 3307' 9' at 3225' T.D. 150'
RB-46 3288' 27' at 3229' 7' at 3188' T.D. 108'
RB-56 3281' 25' at 3254' T.D. 53'
RB-39 3378' 26' at 3231' T.D. 180'
RB-45 3307 26' at 3209' T.D. 127'
RB-44 3280
RB-48 3298 24' at 3233' 8' at 3191' T.D. 120
RB-42 3283' 26' at 3208' T.D. 110'
RB-41 3269' 27' at 3176' T.D. 130'
U
D
D?
Coal Bank
Hay Coulee
Miller Coulee


RB-31
3587'
21' at 3470'
T. D. 140'
RB-30
3594'
-0-
T. D. 68'
RB-28
3568'
25' at 3409'
T. D. 190'
Trail
US(C)
US(D)
RB-65
3505'
27' at 3390'
T. D. 143'
RB-27
3563
27' at 3397'
T. D. 200'
RB-26
3493
26' at 3404'
T. D. 117'
South
RB-24
3480'
25' at 3384'
T.D 130'
RB-25
3537'
27' at 3358'
T D 210'
RB-23
3470'
24' at 3391'
T. D. 110'
D
U
N
ROSEBUD CO.
BIG HORN CO.

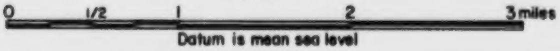
MAP OF

COLSTRIP COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE ROSEBUD COAL BED, ROSEBUD, AND TREASURE COUNTIES, MONTANA

BURLINGTON NORTHERN INC.
V.W. CARMICHAEL, 1964


Scale
0
1/2
1
2
3 miles
Datum is mean sea level

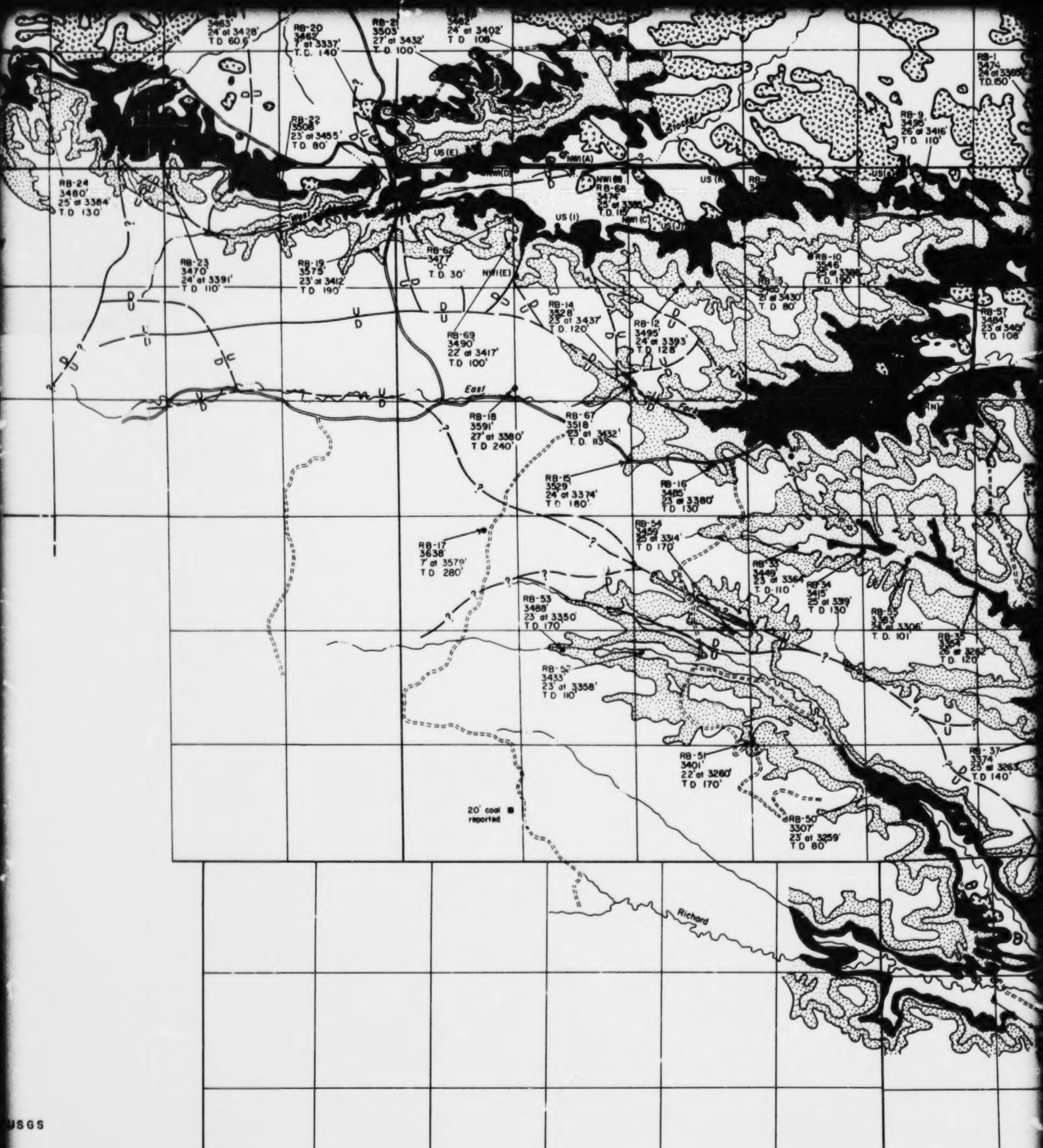
EXPLANATION

~	Rosebud coal bed	
▨	Clinker, dashed line shows infered contact with coal	
■	0 - 50'	Overburden
□	50'-100'	"
▨	100'-150'	"
▨	Mined area	
☧	Small mine	
‑?‑?‑	Fault, dashed where inferred	

● RB-17 3636' 7' at 3579' T.D. 280'	Burlington Northern drill hole altitude at top of collar altitude at top of 7' of coal total depth of drill hole
● NWI(B)	Northwestern Improvement Co.
● MP-2	Montana Power Co.
● US(A)	United States Geological Survey
▲ US(a)	Coal crops, thickness measured by USGS
■	Reported coal thickness

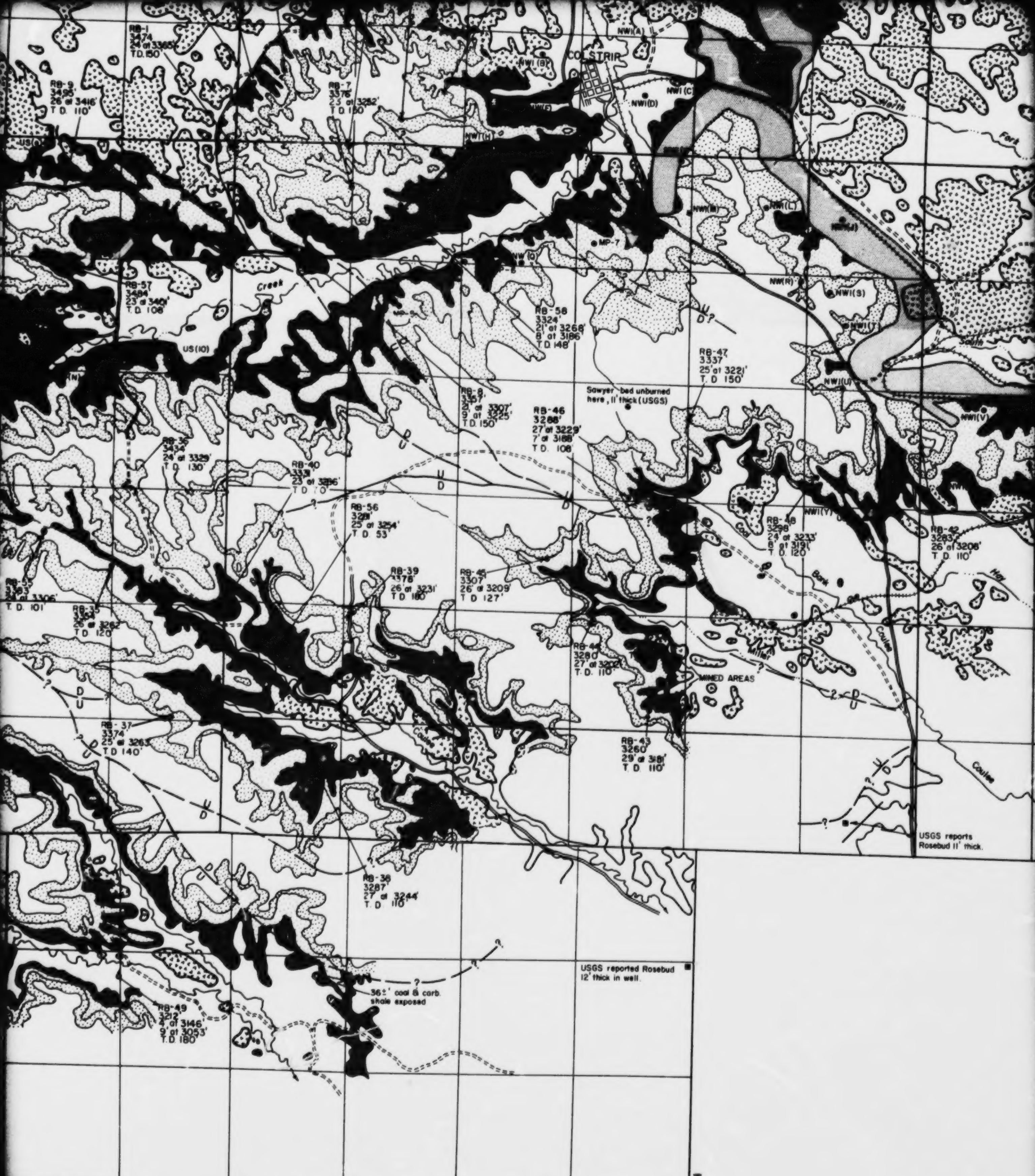
Sec. & t
county
culture
aerial

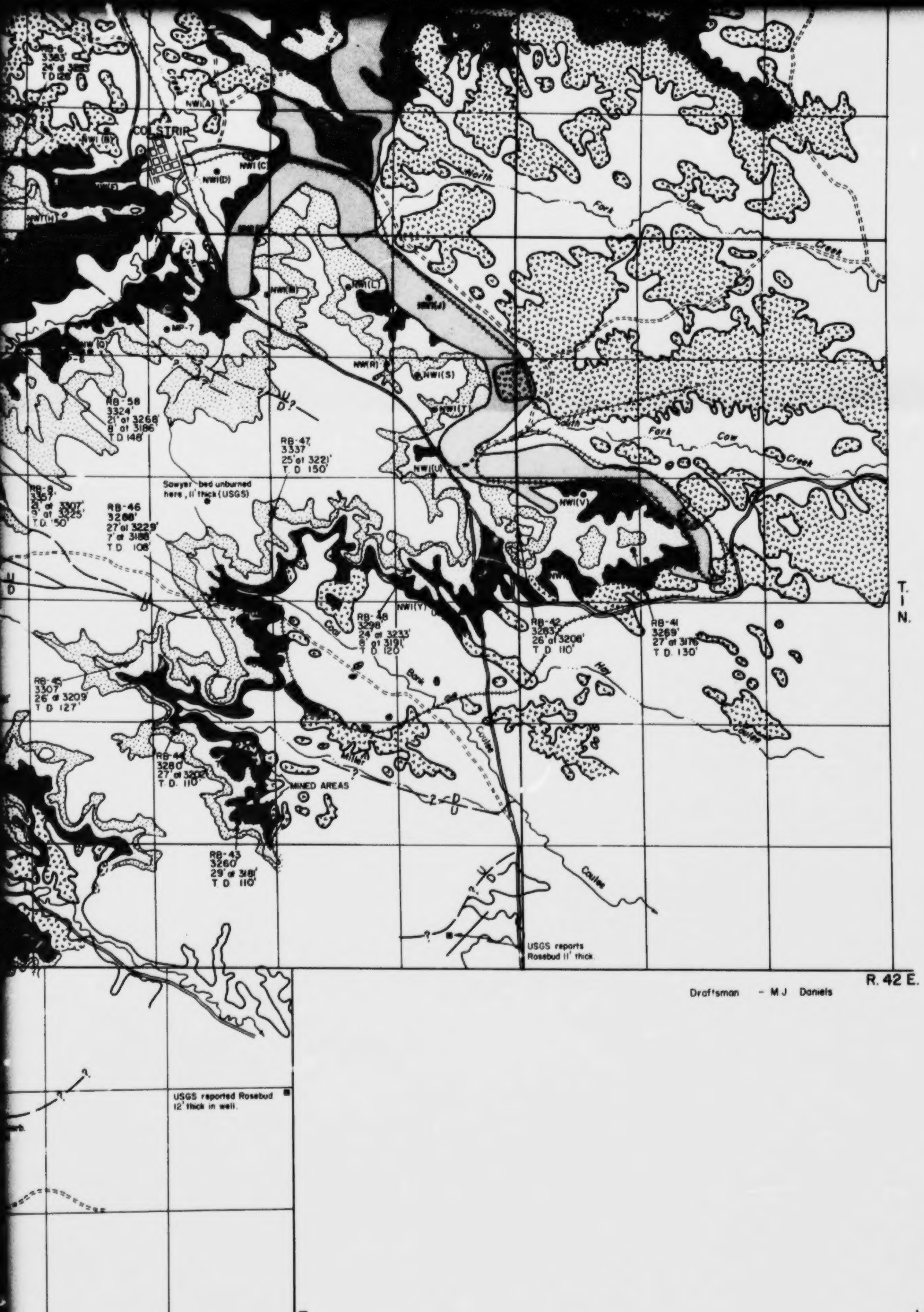
6


3463'
24' at 3428'
T.D. 60.6
RB-20
3462'
7' at 3337'
T.D. 140'
RB-21
3503'
27' at 3432'
T.D. 100'
3462'
24' at 3402'
T.D. 108
RB-1
3474'
24' at 3365'
T.D. 150
RB-22
3508'
23' at 3455'
T.D. 80'
RB-9
3495'
26' at 3416'
T.D. 110'
RB-24
3480'
25' at 3384'
T.D. 130'
RB-68
3474'
25' at 3385'
US (E)
US (I)
US (J)
US (K)
NWI (A)
NWI (B)
NWI (C)
NWI (D)
NWI (E)
RB-23
3470'
24' at 3391'
T.D. 110'
RB-19
3575'
23' at 3412'
T.D. 190'
RB-62
3477'
-0-
T.D. 30'
RB-10
3546'
25' at 3386'
T.D. 130'
RB-11
3495'
21' at 3430'
T.D. 80'
RB-14
3528'
23' at 3437'
T.D. 120'
RB-12
3495'
24' at 3393'
T.D. 128'
RB-57
3484'
23' at 3401'
T.D. 108'
RB-69
3490'
22' at 3417'
T.D. 100'
East
Fork
RB-18
3591'
27' at 3380'
T.D. 240'
RB-67
3518'
23' at 3432'
T.D. 113'
RB-15
3529
24' at 3374'
T.D. 180'
RB-16
3485'
23' at 3380'
T.D. 130
RB-54
3459'
25' at 3314'
T.D. 170'
RB-17
3638'
7' at 3579'
T.D. 280'
RB-33
3449'
23' at 3364'
T.D. 110'
RB-34
3415'
25' at 3319'
T.D. 130
RB-53
3488'
23' at 3350'
T.D. 170'
RB-35
3363'
24' at 3306'
T.D. 101'
RB-36
3354'
26' at 3262'
T.D. 120'
RB-52
3433'
23' at 3358'
T.D. 110'
RB-51
3401'
22' at 3260'
T.D. 170'
RB-37
3374'
25' at 3263'
T.D. 140'
20' coal
reported
RB-50
3307'
23' at 3259'
T.D. 80'
Richard
U
D
USGS

Sec. & twp. grid enlarged from 1"=1 mile scale Mont. Hwy. Dept. county maps (1962) Geologic interpretation, drainage, and culture from 1957, SCS 1:20,000 scale aerial photography

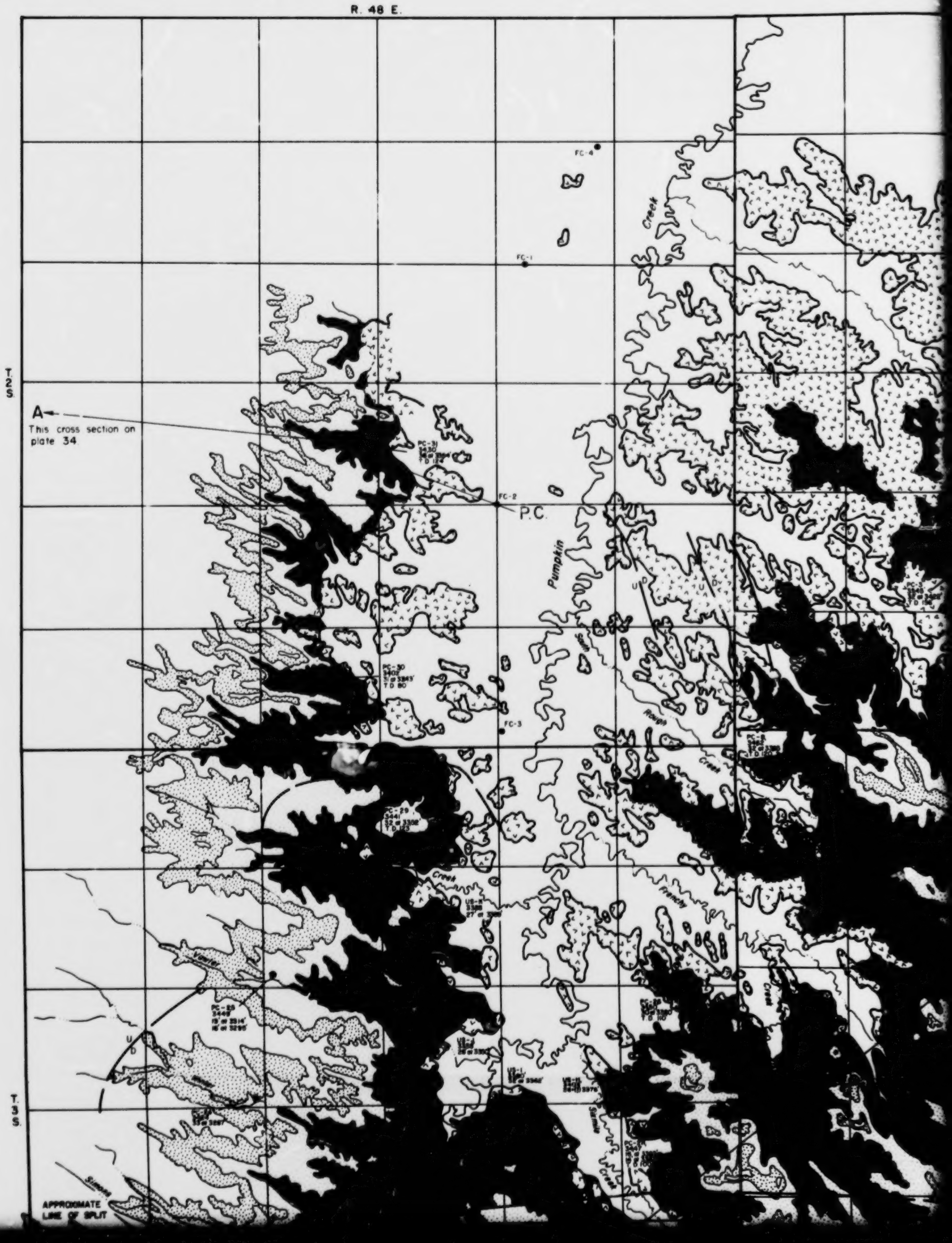
R. 40 E.


RB-1
3474
24' at 3365'
T.D. 150
RB-9
3495'
26' at 3416'
T.D. 110'
US(O)
RB-7
3376'
23' at 3252'
T.D. 150
NWI(A)
NWI(B)
COLSTRIP
NWI(C)
NWI(D)
NWI(F)
NWI(H)
North
Fork
NWI(M)
NWI(L)
NWI(J)
MP-7
NW(O)
NW(R)
NWI(S)
NWI(T)
NWI(U)
South
NWI(V)
Creek
RB-57
3484
23' at 3401'
T.D. 108'
US(10)
(N)
RB-58
3324'
21' at 3268'
8' at 3186'
T.D. 148'
U
D?
RB-47
3337
25' at 3221'
T. D. 150'
Sawyer bed unburned here, 11' thick (USGS)
RB-8
3357'
21' at 3307'
9' at 3225'
T.D. 150'
RB-46
3288'
27' at 3229'
7' at 3188'
T. D. 108'
RB-36
3434
24' at 3329'
T. D. 130'
RB-40
3331'
23' at 3296'
T. D. 110'
U
D
RB-56
3281'
25' at 3254'
T. D. 53'
NWI(Y)
RB-48
3298'
24' at 3233'
8' at 3191'
T. D. 120'
Coal
Bank
RB-42
3283'
26' at 3208'
T. D. 110'
Hay
RB-55
3363
24' at 3306'
T. D. 101'
RB-35
3354
26' at 3262'
T D 120'
RB-39
3378'
26' at 3231'
T D 180'
RB-45
3307'
26' at 3209'
T D 127'
RB-44
3280
27' at 3202'
T. D. 110'
Miller
Coulee
MINED AREAS
?
D
U
RB-37
3374'
25' at 3263'
T D 140'
Coulee
RB-43
3260
29' at 3181'
T. D. 110'
Coulee
USGS reports Rosebud 11' thick.
RB-38
3287'
27' at 3244'
T. D. 110'
USGS reported Rosebud 12' thick in well.
36±' coal & carb. shale exposed
RB-49
3212'
4' at 3146'
9' at 3053'
T.D. 180'
R. 41 E.
T. 1 S.

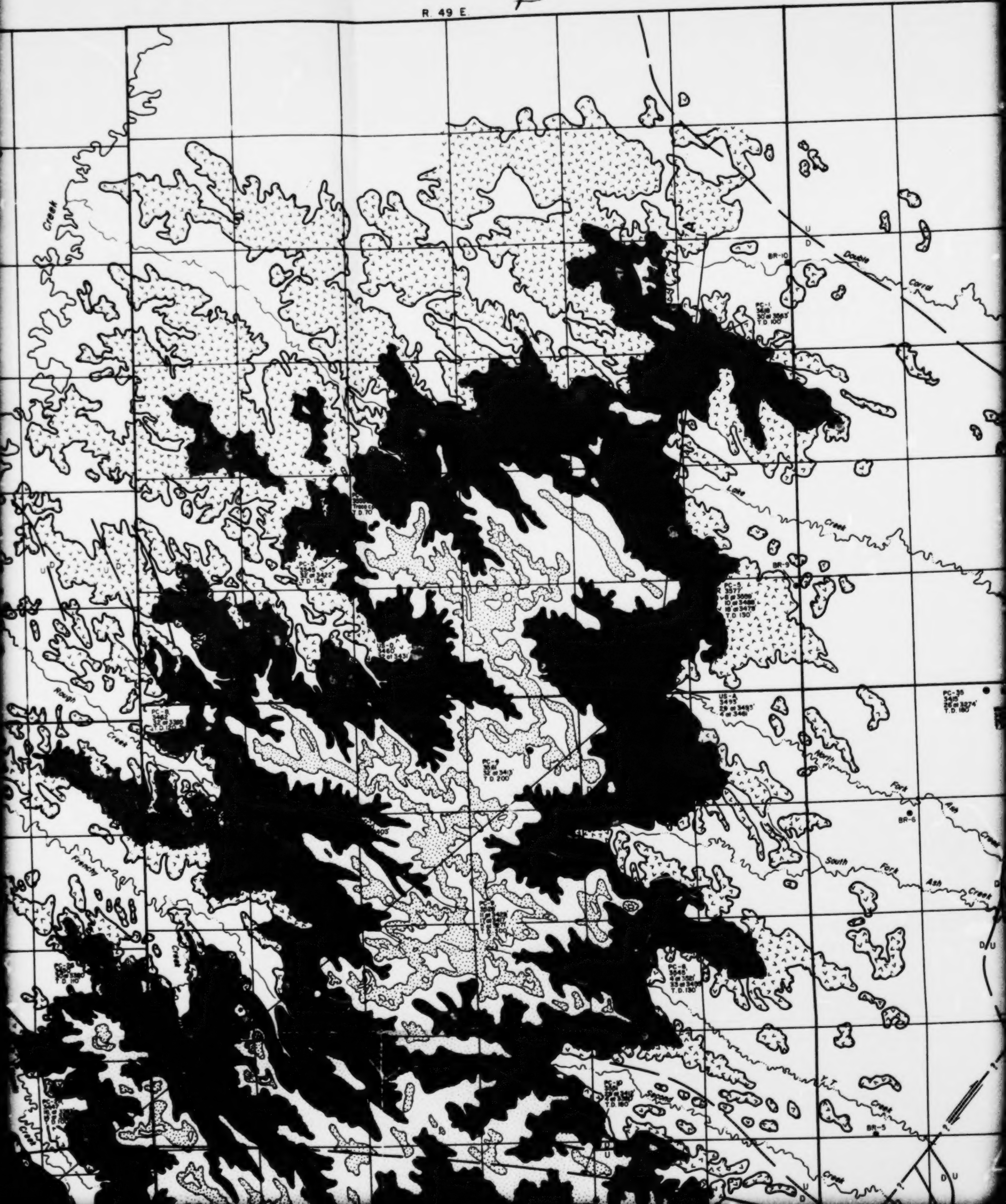

RB-6
3383'
24' at 3285'
TD 28'
COLSTRIP
NWI(A)
NWI(B)
NWI(C)
NWI(D)
NWI(F)
NWI(H)
NWI(K)
NWI(L)
NWI(J)
MP-7
NWI(O)
North Fork Cow Creek
NWI(R)
NWI(S)
NWI(T)
NWI(U)
NWI(V)
RB-58
3324'
21' at 3268'
8' at 3186'
T D 148'
RB-47
3337'
25' at 3221'
T. D. 150'
South Fork Cow Creek
RB-8
3367'
21' at 3307'
9' at 3225'
T.D. 150'
Sawyer bed unburned here, 11' thick (USGS)
RB-46
3288'
27' at 3229'
7' at 3188'
T D 108'
U
D
RB-48
3298'
24' at 3233'
8' at 3191'
T. D. 120'
NWI(Y)
RB-42
3283'
26' at 3208'
T. D. 110'
RB-41
3269'
27' at 3176'
T. D. 130'
T. 1 N.
Coal Bank Coulee
Hay Coulee
RB-45
3307'
26' at 3209'
T D 127'
RB-44
3280'
27' at 3202'
T. D. 110'
Miller Coulee
MINED AREAS
RB-43
3260'
29' at 3181'
T D 110'
Coulee
USGS reports Rosebud 11' thick.
R. 42 E.
Draftsman - M J Daniels
USGS reported Rosebud 12' thick in well.
T. 1 S.

A

MONTANA BUREAU OF MINES AND GEOLOGY


R. 48 E.
T. 2 S.
T. 3 S.
A
This cross section on plate 34
P.C.
FC-4
FC-1
FC-2
FC-3
PC-31
PC-30
PC-29
Creek
Pumpkin
Creek
Rough
Creek
Frenchy
Creek
Creek
Simmons
Creek
U
D
APPROXIMATE LINE OF SPLIT

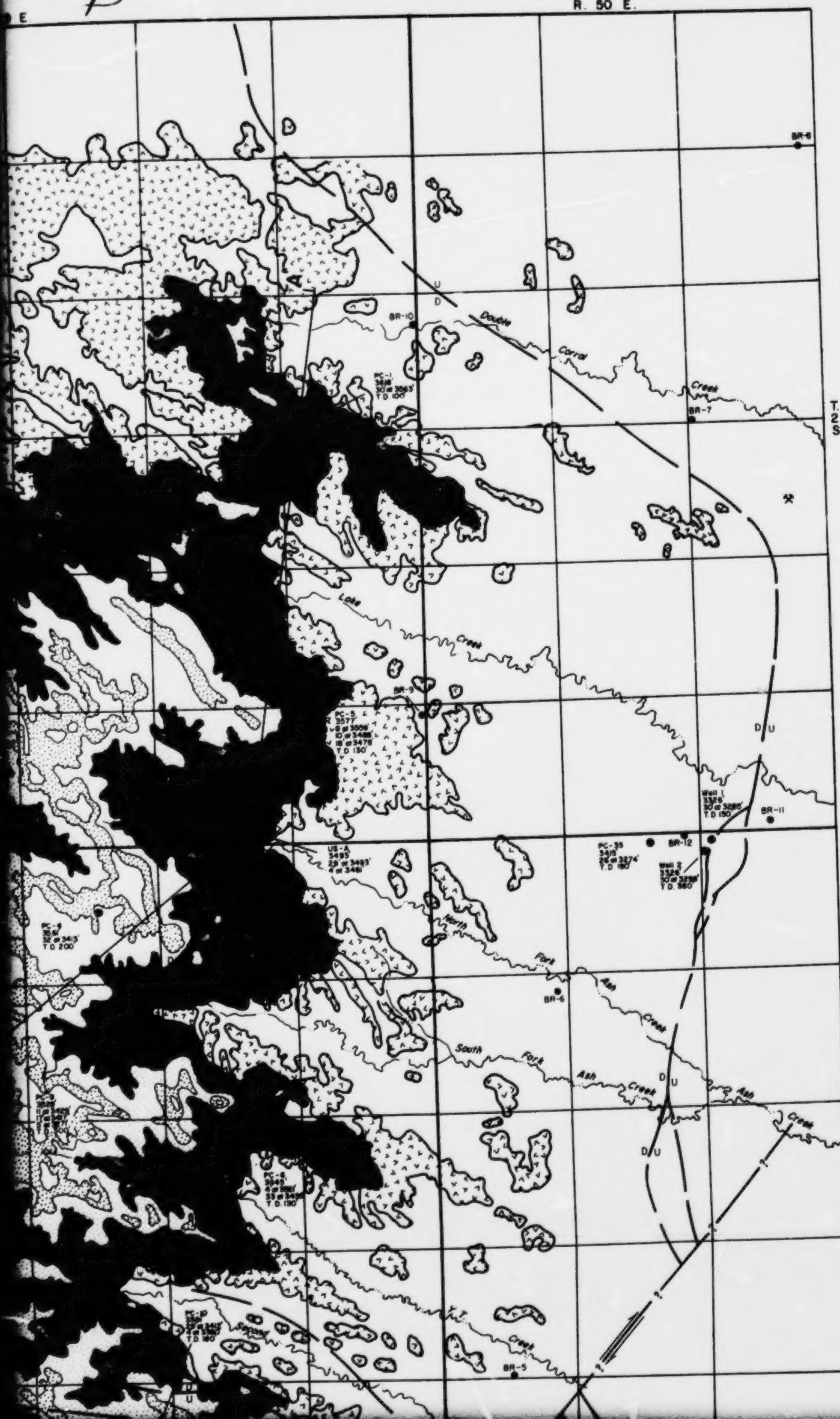
B


R. 49 E.
R. 50 E.
Creek
U
D
BR-10
Double
Corral
PC-1
T.D. 100'
Lake
Creek
BR-9
PC-5
T.D. 130
PC-3
T.D. 156
T.D. 70
US-A
US-D
PC-35
T.D. 180
Rough
Creek
PC-6
T.D. 200
North
Fork
Ash
Creek
BR-6
South
Fork
Ash
Creek
Frenchy
Creek
PC-8
T.D. 130
Second
Creek
BR-5
Creek
D U

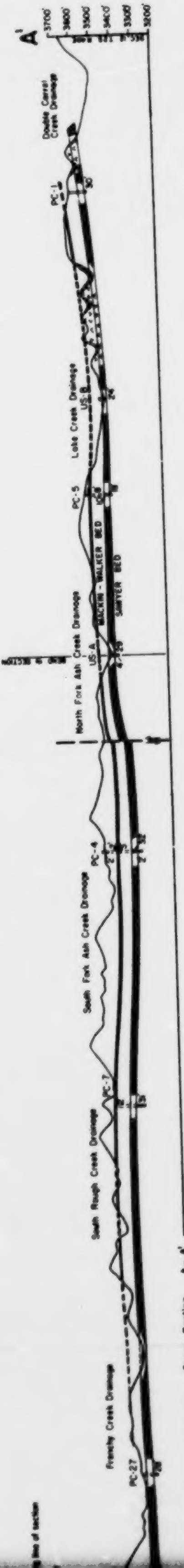
B

BULLETIN 91 PLATE 15

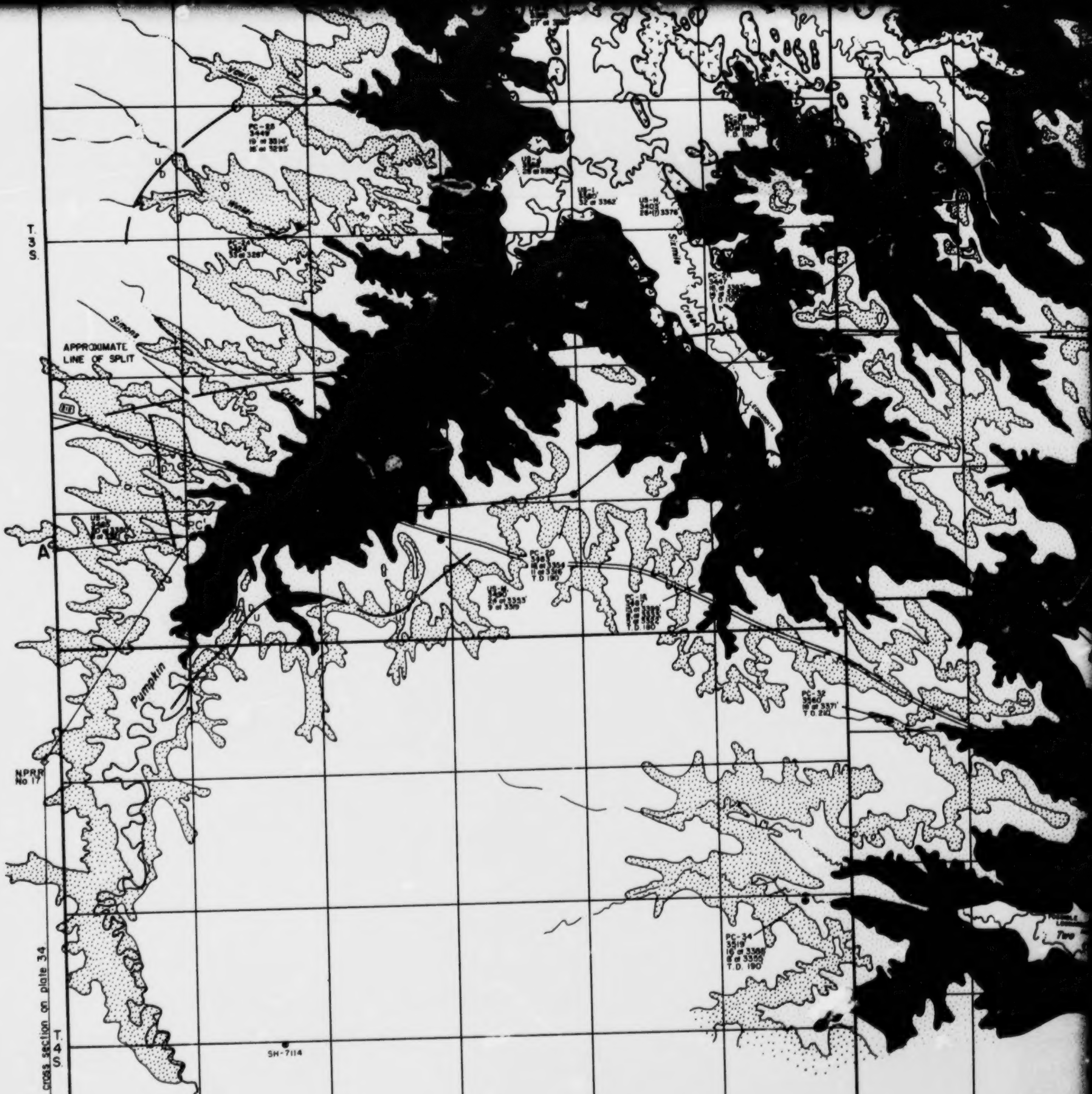
C



E
R. 50 E.
BR-6
A
U
D
BR-10
Double
Corral
Creek
PC-1
3618'
30 at 3563'
T.D. 100
BR-7
T.
2
S.
Lake
Creek
BR-9
PC-5
3577'
8 at 3500'
10 at 3488'
18 at 3478'
T.D. 130
D U
Well 1
3326'
30 at 3280'
T.D. 150
BR-11
PC-35
3415'
24 at 3374'
T.D. 160
BR-12
Well 2
3326'
30 at 3286'
T.D. 560
US-A
3493'
29 at 3493'
4 at 3461'
PC-4
3614'
T.D. 200
North
Fork
Ash
Creek
BR-8
South
Fork
Ash
Creek
Ash
Creek
D U
D U
PC-6
T.D. 130
PC-10
T.D. 160
Creek
BR-5
T.
3
S.
D
U



A'
3700'
3600'
3500'
3400'
3300'
3200'
Double Corral Creek Drainage
PC-1
30
Lake Creek Drainage
US-B
24
PC-5
18
MACKIN - WALKER BED
SAWYER BED
North Fork Ash Creek Drainage
US-A
PC-4
South Fork Ash Creek Drainage
PC-7
South Rough Creek Drainage
Frenchy Creek Drainage
PC-27
Cross Section A-A'


T. 3 S.
APPROXIMATE LINE OF SPLIT
Simons Creek
Pumpkin
Simmie Creek
A
PC
NPRR No 17
PC-34 3519 16 at 3388 6 at 3355 T.D. 190
SH-7114
T. 4 S.
This cross section on plate 34
OC
R. 48 E.

Base map: Sec and Twp. grid enlarged from 1" = 1 mile Montana Hwy. Dept. Powder River County Map, Geologic interpretation, drainage, and culture from 1954, CSS, 1:20,000 aerial photography.

Scale
0 1/2 1 2 miles
Datum is mean sea level

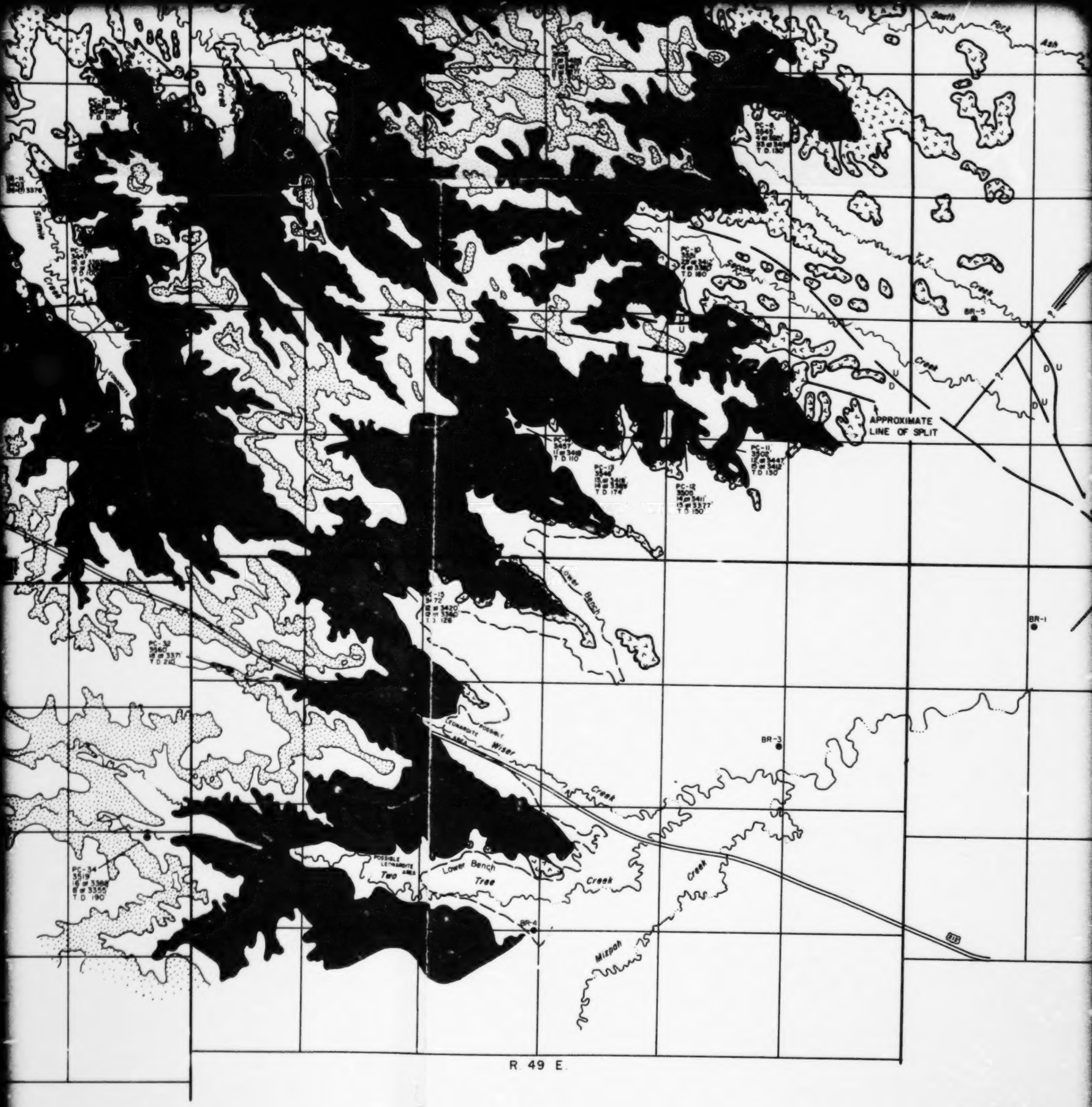
N

MAP

PUMPKIN CREEK

SHOW

STRIPPABLE RESERVES I
POWDER RIVER

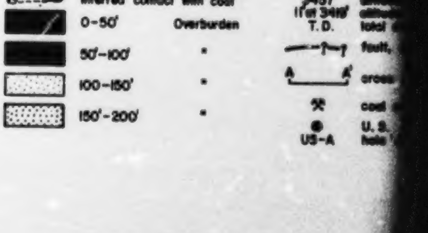

South Fork Ash Creek
Sawmill Creek
Second Creek
APPROXIMATE LINE OF SPLIT
Lower Bench
POSSIBLE LEONARDITE AREA
Wiser Creek
Two Tree Creek
Mizpah Creek
BR-1
BR-3
BR-4
BR-5
PC-11
PC-12
PC-13
PC-14
PC-15
PC-32
PC-34
332
R 49 E

MAP OF

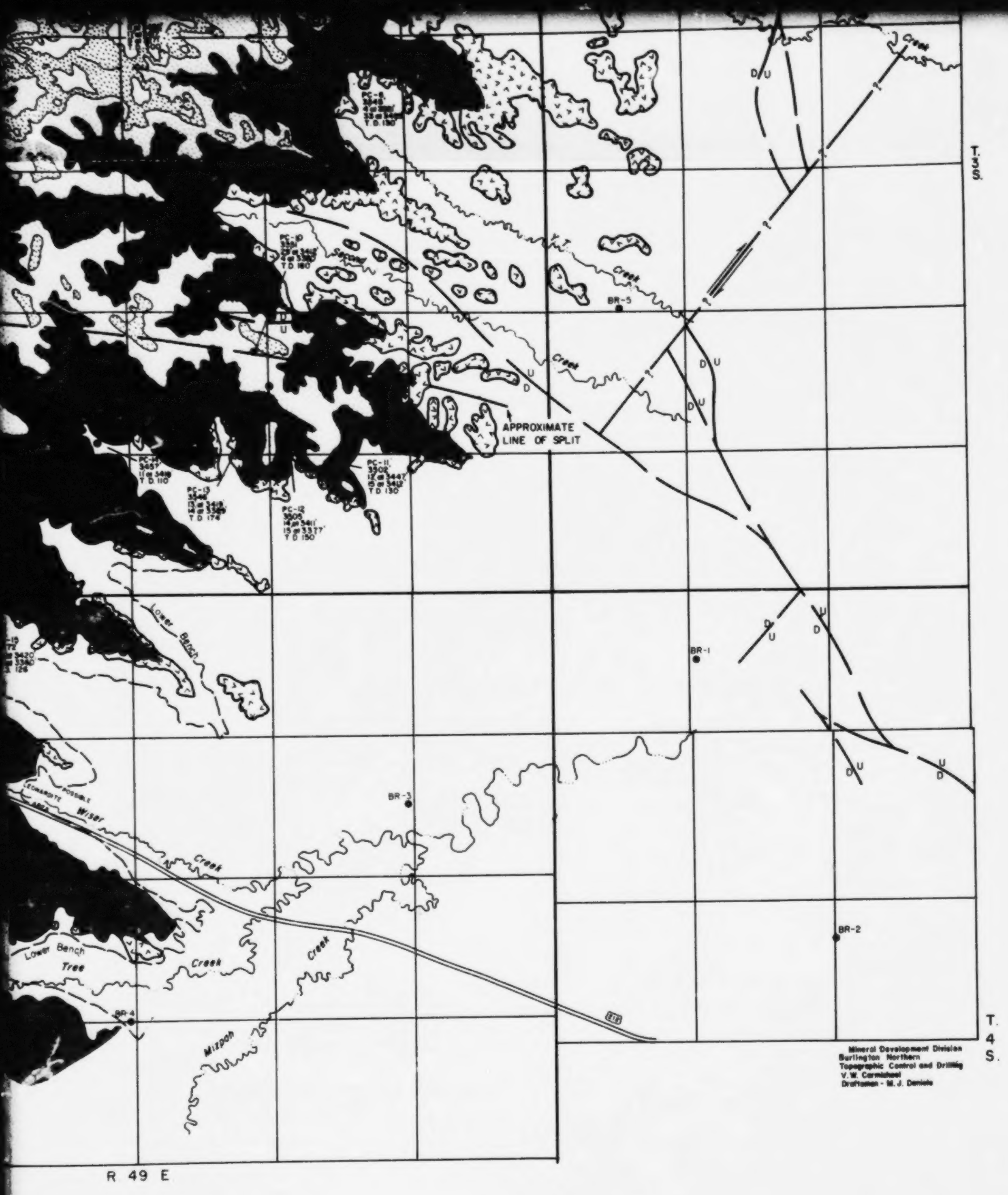
PUMPKIN CREEK COAL DEPOSIT

SHOWING

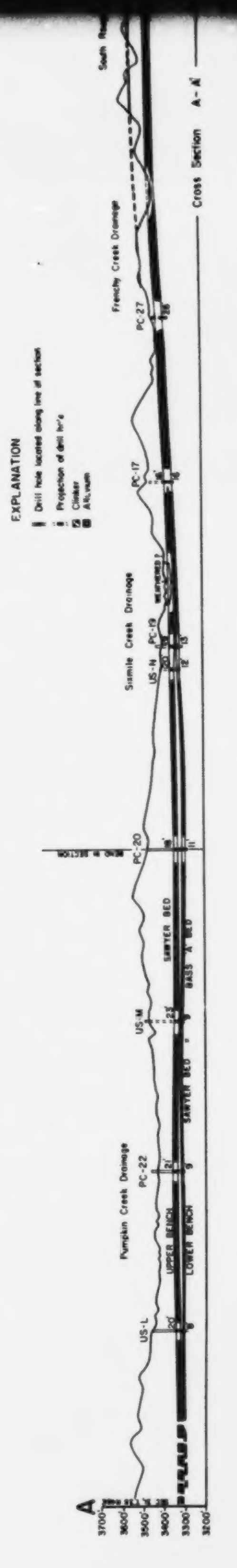
STRIPPABLE RESERVES IN THE SAWYER COAL BED, POWDER RIVER COUNTY, MONTANA


EXPLANATION
Sawyer coal bed
Clinker, dotted line shows inferred contact with coal
0-50' Overburden
50'-100' "
100-150' "
150'-200' "
PC-14
3457'
11 at 3418'
T.D.
US-A

6


APPROXIMATE LINE OF SPLIT
Creek
Second
Lower Bench
Wiser
Creek
Lower Bench
Tree
Creek
Mizpah
Creek
BR-1
BR-2
BR-3
BR-4
BR-5
PC-10
PC-11
PC-12
PC-13
PC-14
D
U
T. 4 S.
R 49 E

Mineral Development Division
Burlington Northern
Topographic Control and Drilling
V.W. Carmichael
Draftsman - M. J. Daniels


Cross Section A-A'
EXPLANATION
Drill hole located along line of section
Projection of drill hole
Clinker
Alluvium
South Fork
Frenchy Creek Drainage
Sixmile Creek Drainage
Pumpkin Creek Drainage
PC-27
PC-17
PC-19
US-N
PC-20
US-M
PC-22
US-L
SAWYER BED
BASS 'A' BED
UPPER BENCH
LOWER BENCH
A
3700'
3600'
3500'
3400'
3300'
3200'

COAL DEPOSIT

THE SAWYER COAL BED,
NTY, MONTANA

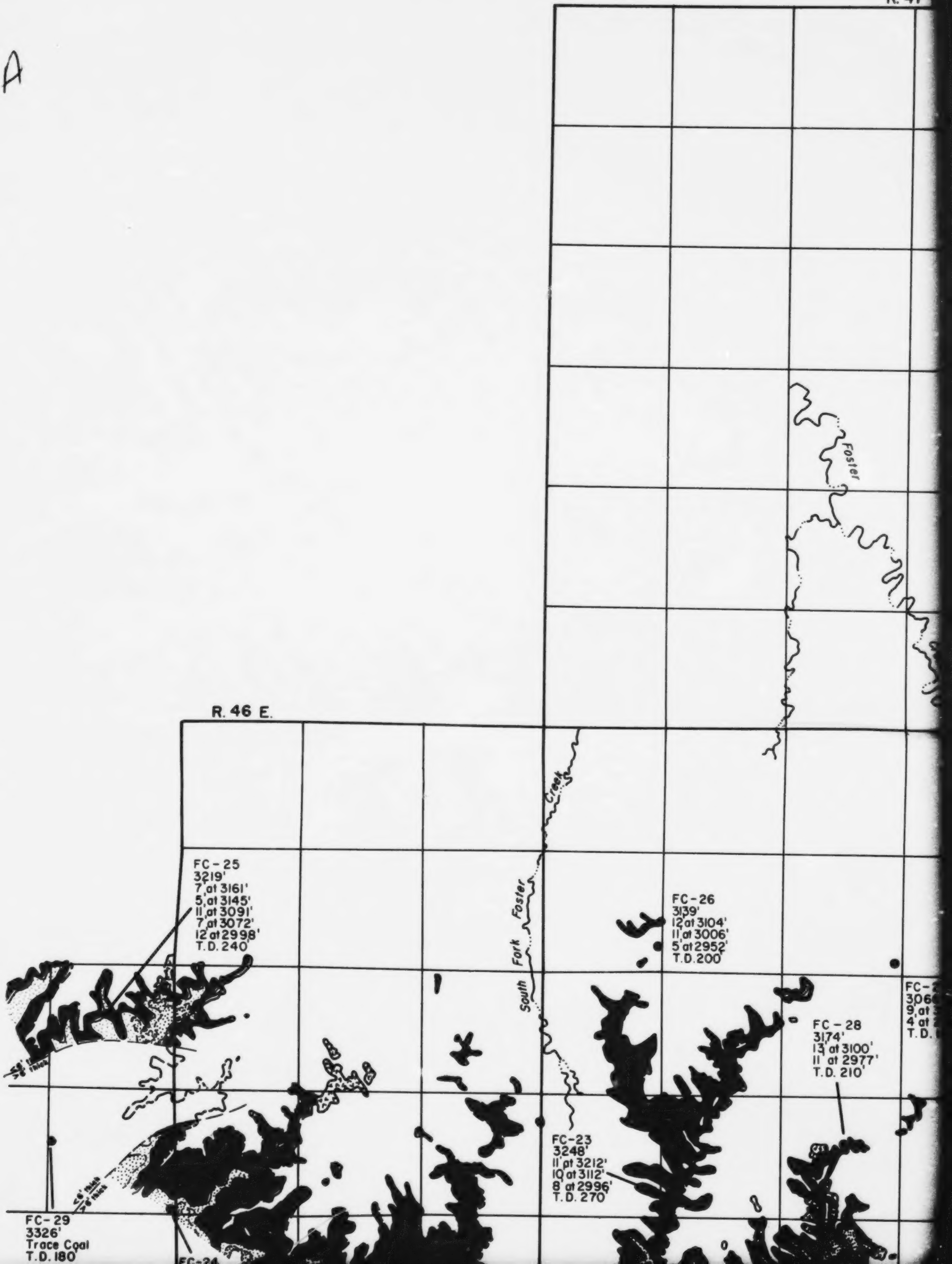
EXPLANATION

〰	Sawyer coal bed	
	Clinker, dotted line shows inferred contact with coal	
■	0-50'	Overburden
■	50'-100'	"
□	100-150'	"
▨	150'-200'	"

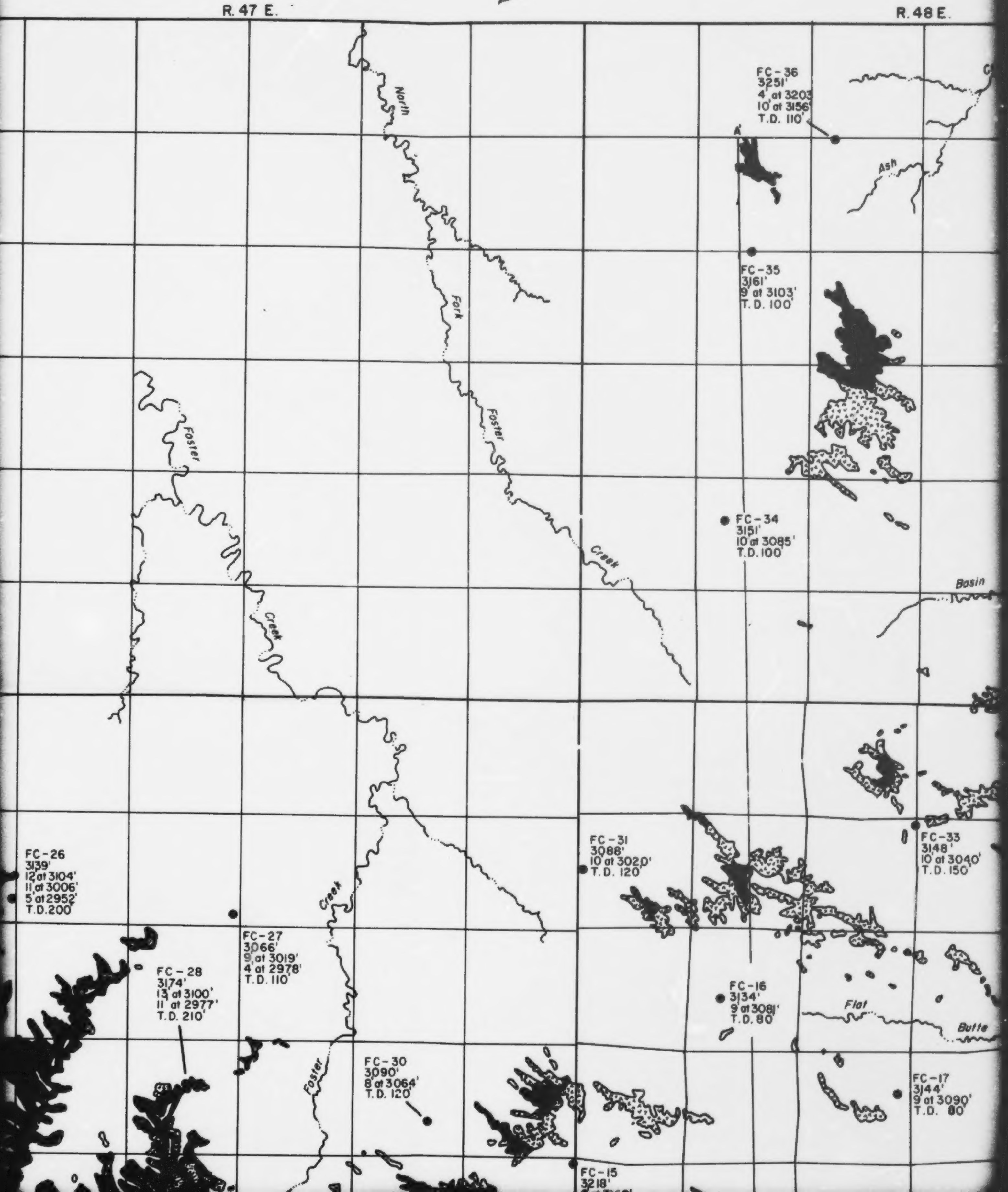
●	Burlington Northern drill hole
PC-14	hole designation
3457'	altitude at top of collar
11' at 3419'	altitude at top of 11' of coal
T.D.	total depth of drill hole
—?—?	fault, dashed where inferred
A A'	cross section A-A'
⚒	coal mine
●	U. S. Geological Survey drill hole
US-A	hole designation

MONTANA BUREAU OF MINES AND GEOLOGY

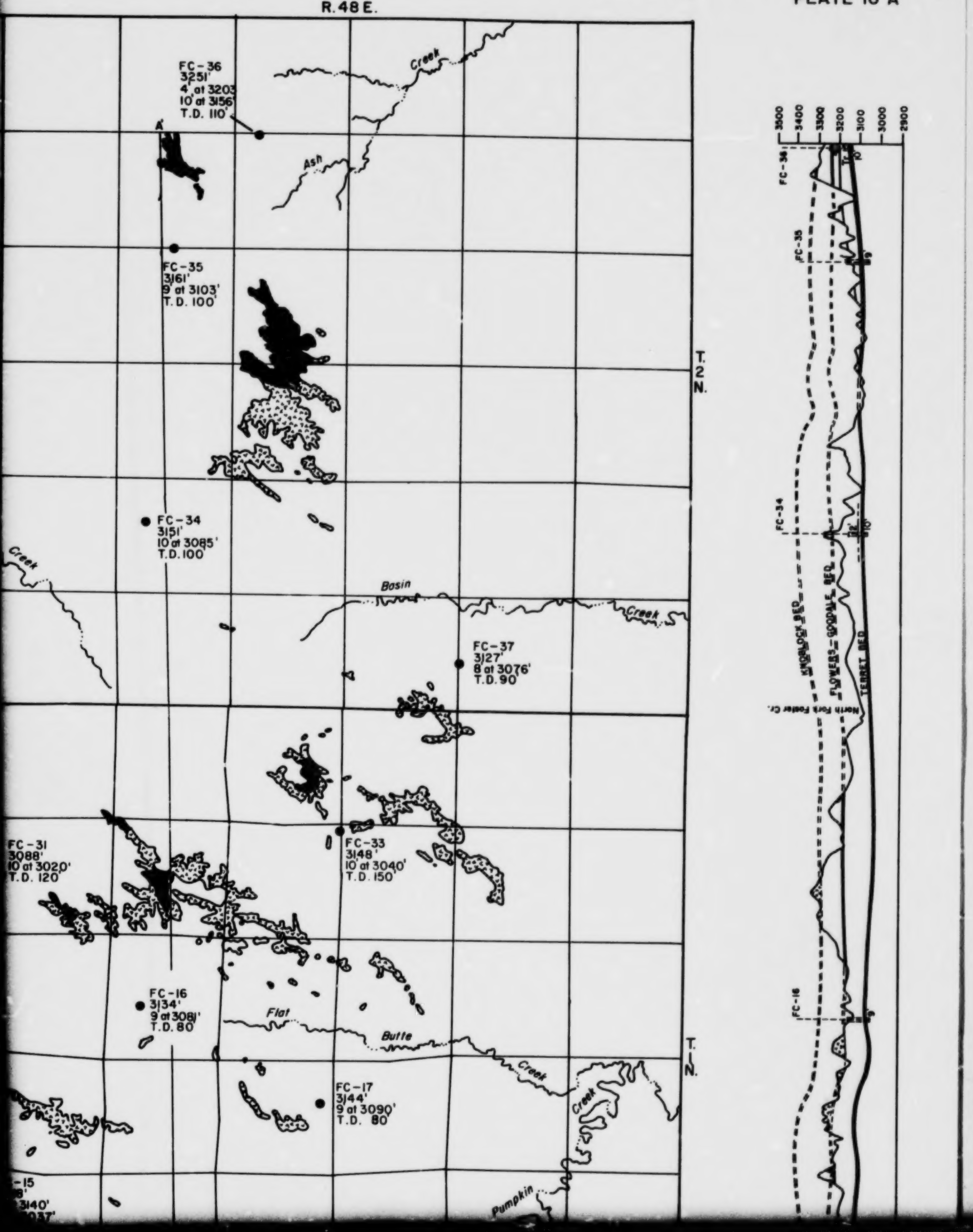
A

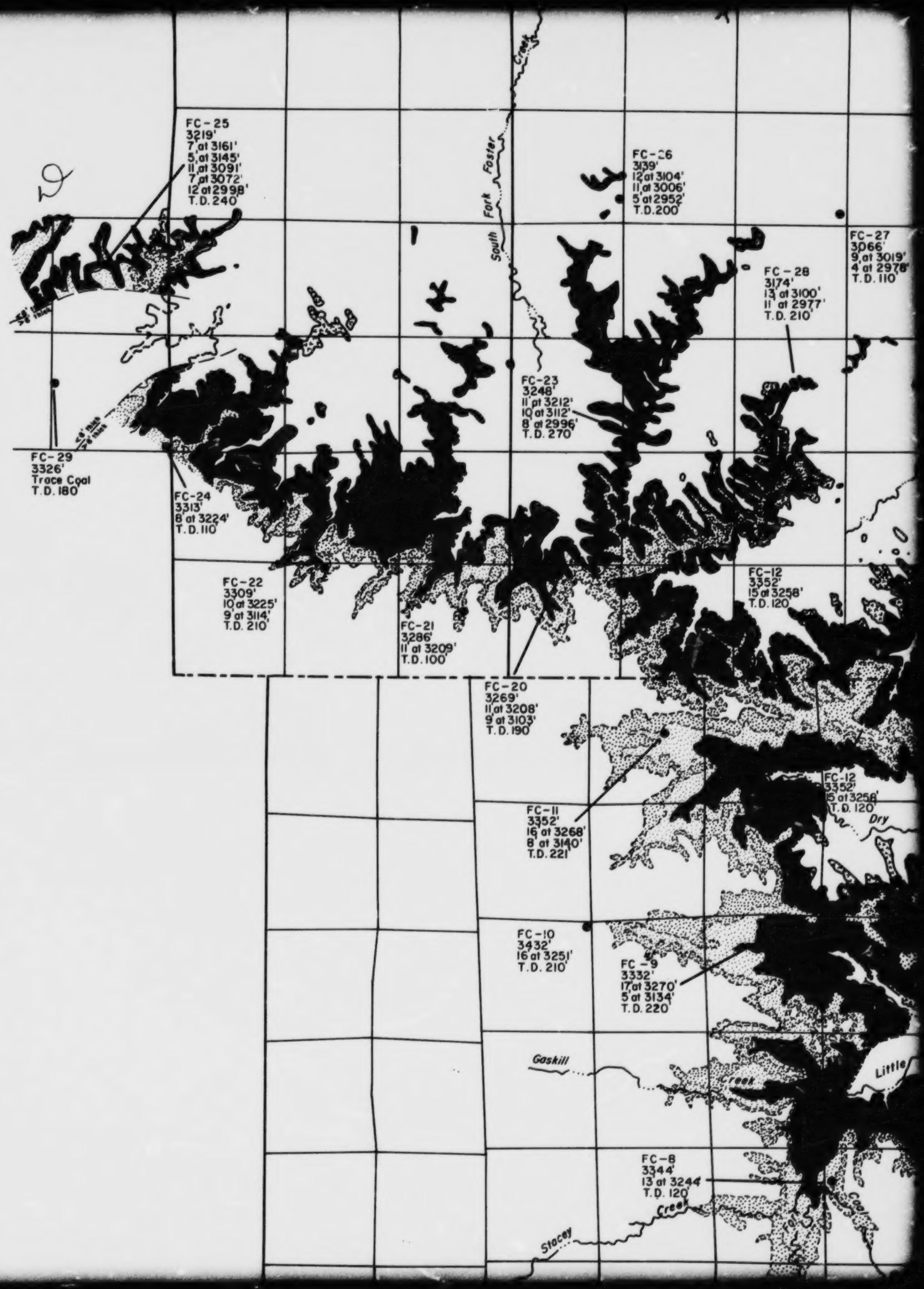

R. 47
R. 46 E.
Foster
Creek
South Fork Foster
FC-25
3219'
7' at 3161'
5' at 3145'
11' at 3091'
7' at 3072'
12 at 2998'
T.D. 240'
FC-26
3139'
12' at 3104'
11' at 3006'
5' at 2952'
T.D. 200'
FC-
306
9' at
4' at
T.D.
FC-28
3174'
13' at 3100'
11 at 2977'
T.D. 210'
FC-23
3248'
11' at 3212'
10 at 3112'
8 at 2996'
T.D. 270'
FC-29
3326'
Trace Coal
T.D. 180'
FC-24

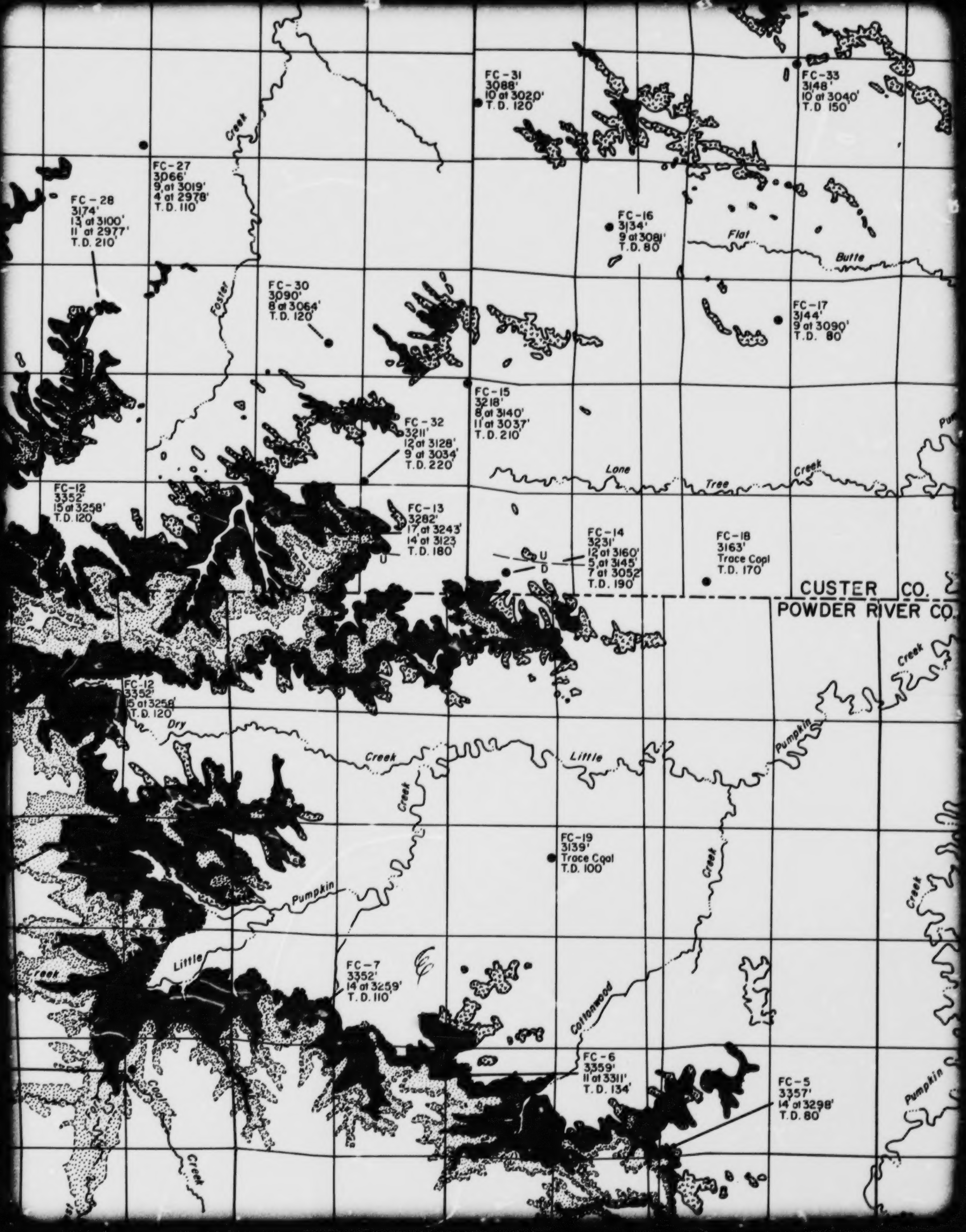
B

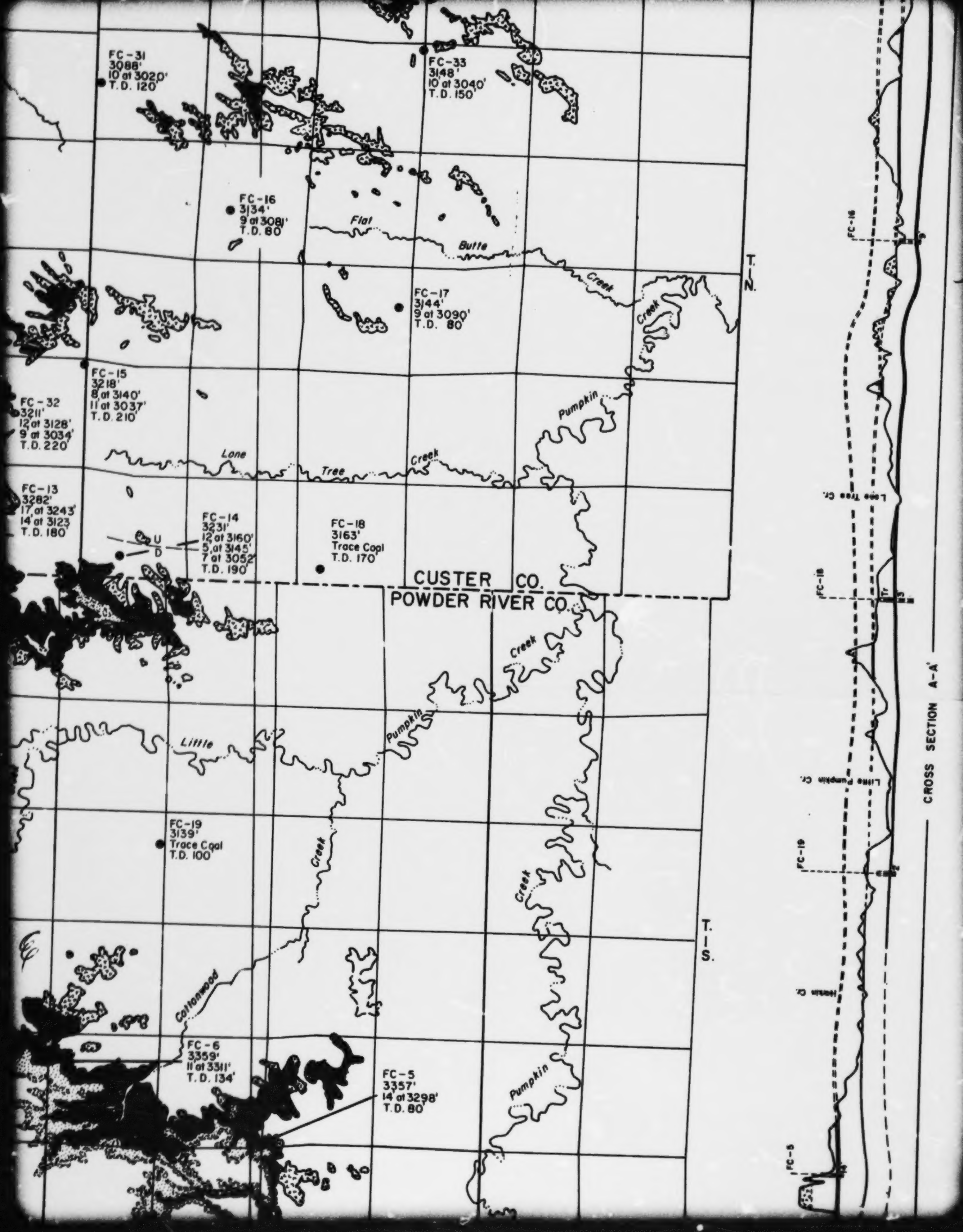

R. 47 E.
R. 48 E.
FC-36
3251'
4' at 3203
10' at 3156'
T.D. 110'
A'
Ash
Cr
North
Fork
Foster
Creek
FC-35
3161'
9' at 3103'
T.D. 100'
Foster
Creek
FC-34
3151'
10' at 3085'
T.D. 100
Basin
FC-31
3088'
10' at 3020'
T.D. 120'
FC-33
3148'
10' at 3040'
T.D. 150'
FC-26
3139'
12' at 3104'
11' at 3006'
5' at 2952'
T.D. 200'
Creek
FC-27
3066'
9' at 3019'
4' at 2978'
T.D. 110'
FC-28
3174'
13' at 3100'
11' at 2977'
T.D. 210'
FC-16
3134'
9' at 3081'
T.D. 80'
Flat
Butte
Foster
FC-30
3090'
8' at 3064'
T.D. 120'
FC-17
3144'
9' at 3090'
T.D. 80'
FC-15
3218'

BULLETIN 91 PLATE 16 A C

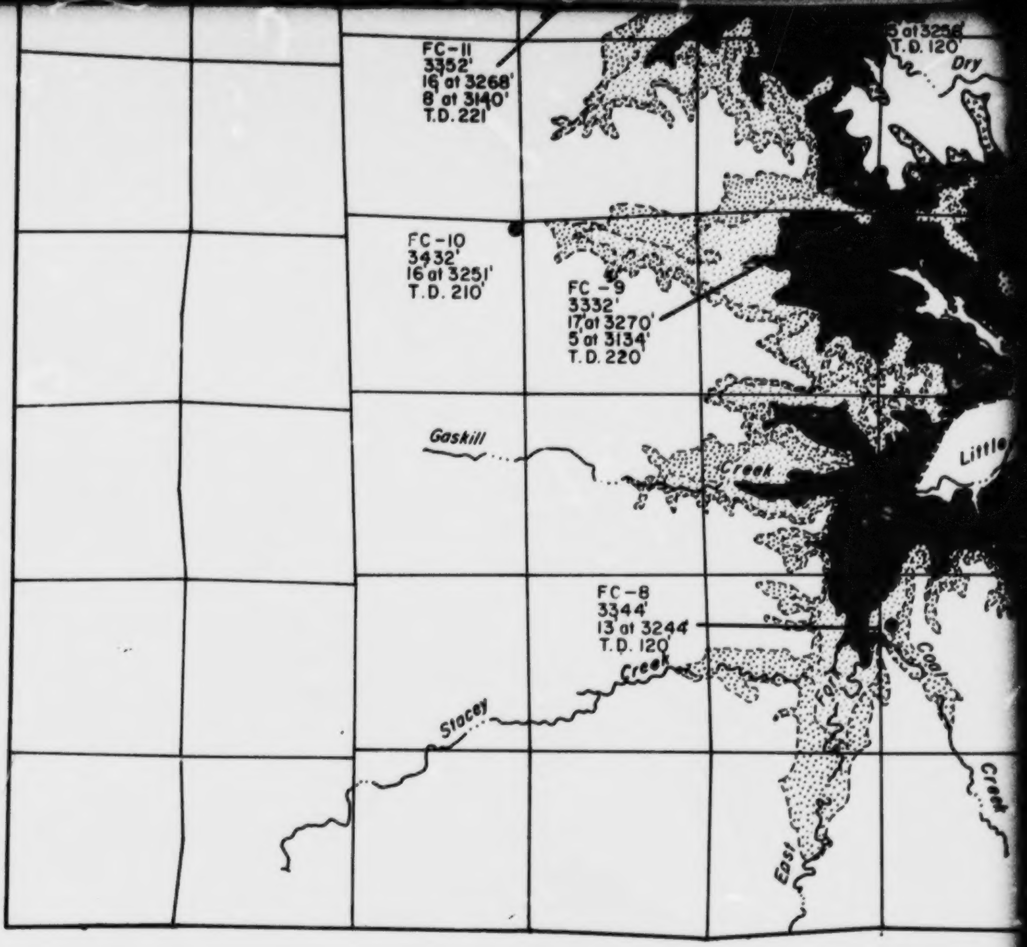

R. 48 E.
T. 2 N.
T. 1 N.
FC-36 3251' 4' at 3203 10' at 3156' T.D. 110'
A'
Creek
Ash
FC-35 3161' 9' at 3103' T.D. 100'
FC-34 3151' 10' at 3085' T.D. 100
Creek
Basin
Creek
FC-37 3127' 8' at 3076' T.D. 90'
FC-31 3088' 10' at 3020' T.D. 120'
FC-33 3148' 10' at 3040' T.D. 150'
FC-16 3134' 9' at 3081' T.D. 80'
Flat
Butte
Creek
FC-17 3144' 9' at 3090' T.D. 80'
Creek
Pumpkin
-15
3140'
3500
3400
3300
3200
3100
3000
2900
FC-36
FC-35
FC-34
FC-16
KNOBLOCK BED
FLOWERS-GOODALE BED
TERRET BED
North Fork Foster Cr.


FC-25
3219'
7' at 3161'
5' at 3145'
11' at 3091'
7' at 3072'
12' at 2998'
T.D. 240'
FC-26
3139'
12' at 3104'
11' at 3006'
5' at 2952'
T.D. 200'
South Fork Foster Creek
FC-27
3066'
9' at 3019'
4' at 2978'
T.D. 110'
FC-28
3174'
13' at 3100'
11' at 2977'
T.D. 210'
FC-23
3248'
11' at 3212'
10' at 3112'
8' at 2996'
T.D. 270'
FC-29
3326'
Trace Coal
T.D. 180'
FC-24
3313'
8' at 3224'
T.D. 110'
FC-22
3309'
10' at 3225'
9' at 3114'
T.D. 210'
FC-21
3286'
11' at 3209'
T.D. 100'
FC-12
3352'
15' at 3258'
T.D. 120'
FC-20
3269'
11' at 3208'
9' at 3103'
T.D. 190'
FC-12
3352'
15' at 3258'
T.D. 120'
Dry
FC-11
3352'
16' at 3268'
8' at 3140'
T.D. 221'
FC-10
3432'
16' at 3251'
T.D. 210'
FC-9
3332'
17' at 3270'
5' at 3134'
T.D. 220'
Gaskill
Creek
Little
FC-8
3344'
13' at 3244'
T.D. 120'
Creek
Stacey
Fork
Coal


FC-31
3088'
10 at 3020'
T.D. 120'
FC-33
3148'
10 at 3040'
T.D. 150'
Creek
FC-27
3066'
9 at 3019'
4 at 2978'
T.D. 110
FC-28
3174'
13 at 3100'
11 at 2977'
T.D. 210'
FC-16
3134'
9 at 3081'
T.D. 80
Flat
Butte
Foster
FC-30
3090'
8 at 3064'
T.D. 120'
FC-17
3144'
9 at 3090'
T.D. 80
FC-15
3218'
8 at 3140'
11 at 3037'
T.D. 210'
FC-32
3211'
12 at 3128'
9 at 3034'
T.D. 220'
Lone
Tree
Creek
FC-12
3352'
15 at 3258'
T.D. 120
FC-13
3282'
17 at 3243'
14 at 3123
T.D. 180'
U
D
FC-14
3231'
12 at 3160'
5 at 3145'
7 at 3052'
T.D. 190'
FC-18
3163'
Trace Coal
T.D. 170
CUSTER CO.
POWDER RIVER CO.
Creek
FC-12
3352'
15 at 3258'
T.D. 120
Dry
Creek
Little
Pumpkin
Creek
FC-19
3139'
Trace Coal
T.D. 100
Creek
Pumpkin
Creek
Creek
Little
FC-7
3352'
14 at 3259'
T.D. 110'
Cottonwood
FC-6
3359'
11 at 3311'
T.D. 134'
FC-5
3357'
14 at 3298'
T.D. 80
Pumpkin
Coal
Creek


FC-31
3088'
10 at 3020'
T.D. 120'
FC-33
3148'
10 at 3040'
T.D. 150'
FC-16
3134'
9 at 3081'
T.D. 80
Flat
Butte
Creek
T. 1 N.
FC-17
3144'
9 at 3090'
T.D. 80'
Creek
FC-15
3218'
8 at 3140'
11 at 3037'
T.D. 210'
FC-32
3211'
12 at 3128'
9 at 3034'
T.D. 220'
Pumpkin
Lone
Tree
Creek
FC-13
3282'
17 at 3243'
14 at 3123
T.D. 180'
FC-14
3231'
12 at 3160'
5 at 3145'
7 at 3052'
T.D. 190'
U
D
FC-18
3163'
Trace Coal
T.D. 170'
CUSTER CO.
POWDER RIVER CO.
Creek
Pumpkin
Little
FC-19
3139'
Trace Coal
T.D. 100'
Creek
Creek
T. 1 S.
Cottonwood
FC-6
3359'
11 at 3311'
T.D. 134'
FC-5
3357'
14 at 3298'
T.D. 80
Pumpkin
FC-16
FC-18
Tr
Lone Tree Cr.
Little Pumpkin Cr.
FC-19
Hanlin Cr.
FC-5
CROSS SECTION A-A'

21



FC-11
3352'
16 at 3268'
8 at 3140'
T.D. 221'
5 at 3256'
T.D. 120'
Dry
FC-10
3432'
16 at 3251'
T.D. 210'
FC-9
3332'
17 at 3270'
5 at 3134'
T.D. 220'
Gaskill
Creek
Little
FC-8
3344'
13 at 3244'
T.D. 120'
Stacey
Creek
Fork
Coal
Creek
East

MAP OF

FOSTER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCK COAL BED, CUSTER AND POWDER RIVER COUNTIES, MONTANA

SCALE

0 1/2 1 2 Miles

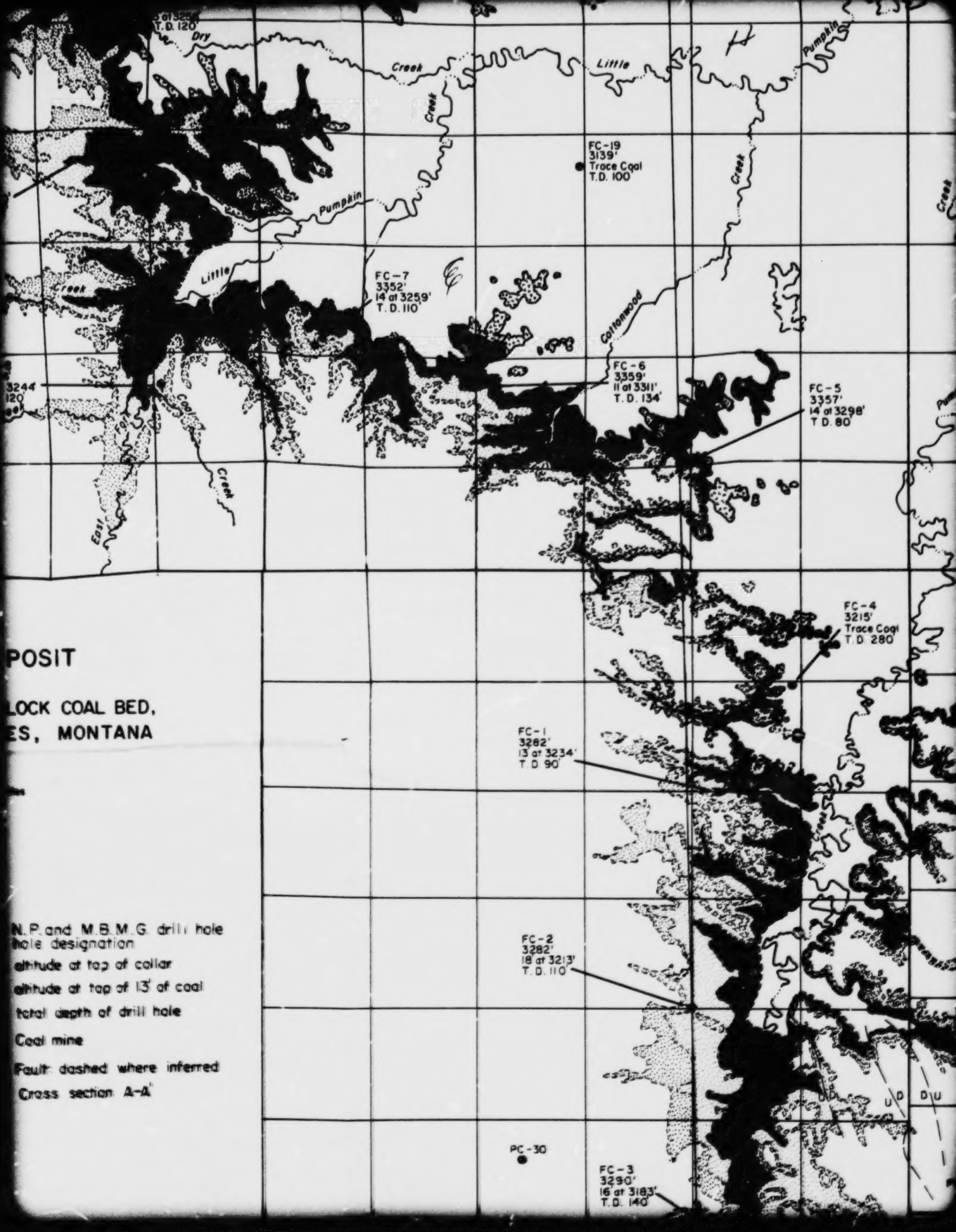
DATUM IS MEAN SEA LEVEL

EXPLANATION

- - - - -	Knoblock coal bed
▨	Clinker
■	0 - 60' overbuden
░	60'-90' "
▒	90'-120' "

●	N. P. and M.B.M.G. drill hole
FC-8	hole designation
3344'	altitude at top of collar
13' at 3244'	altitude at top of 13' of coal
T. D. 120'	total depth of drill hole
⚒	Coal mine
D/U	Fault: dashed where inferred
A A'	Cross section A-A'

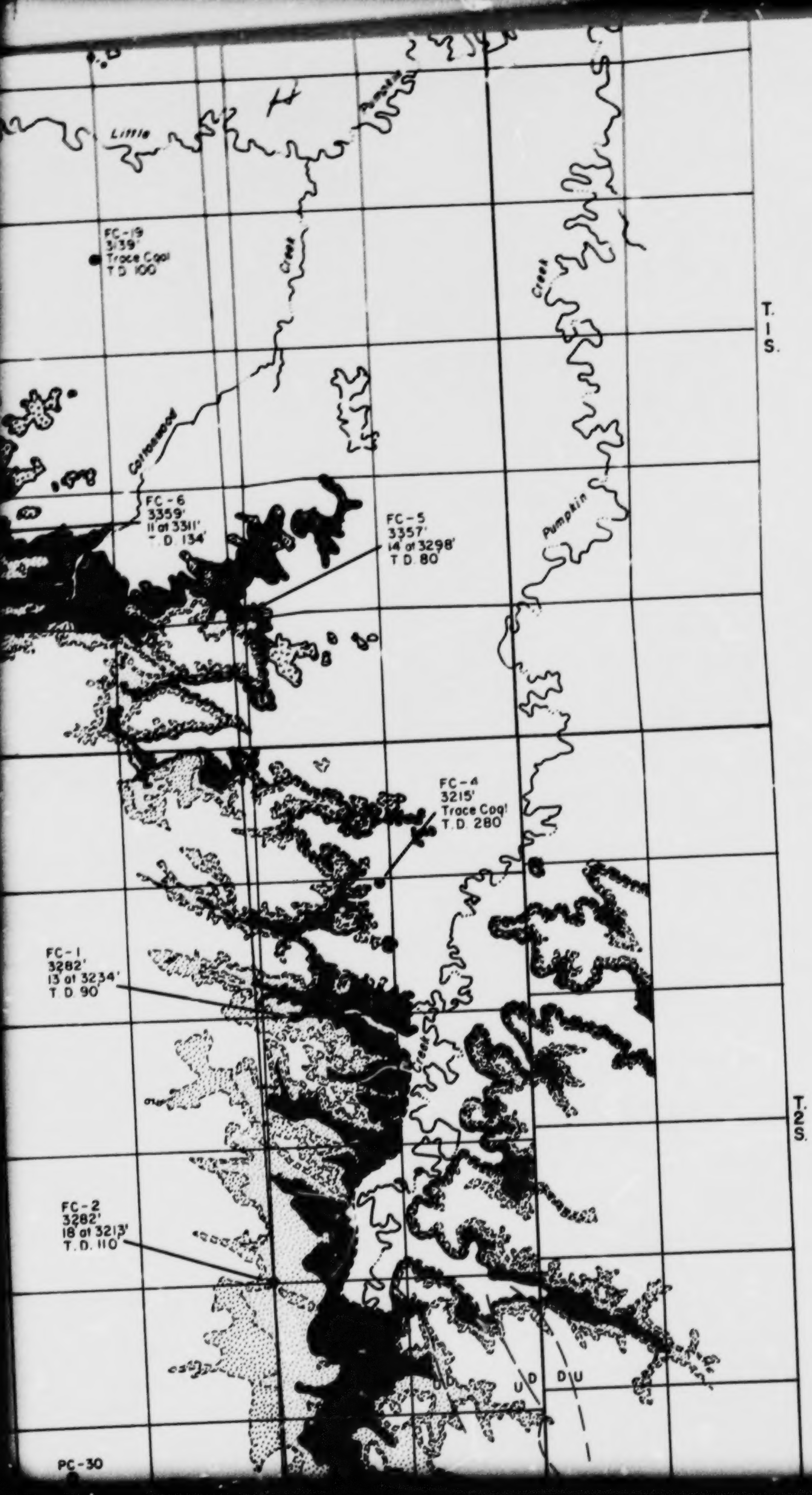
N

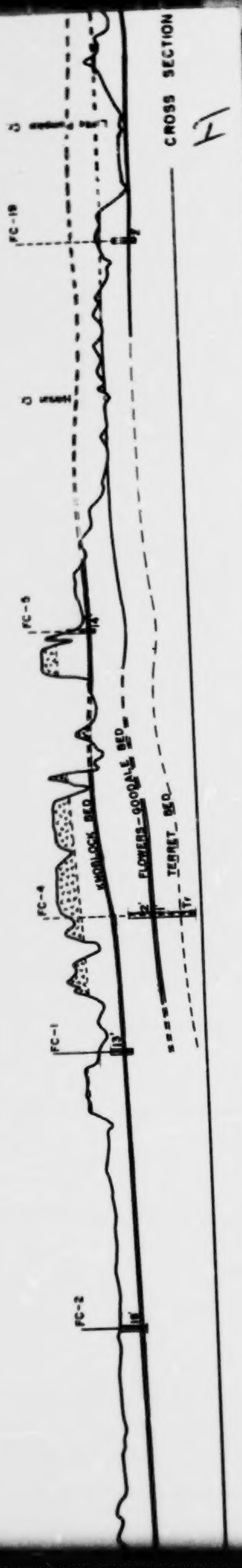


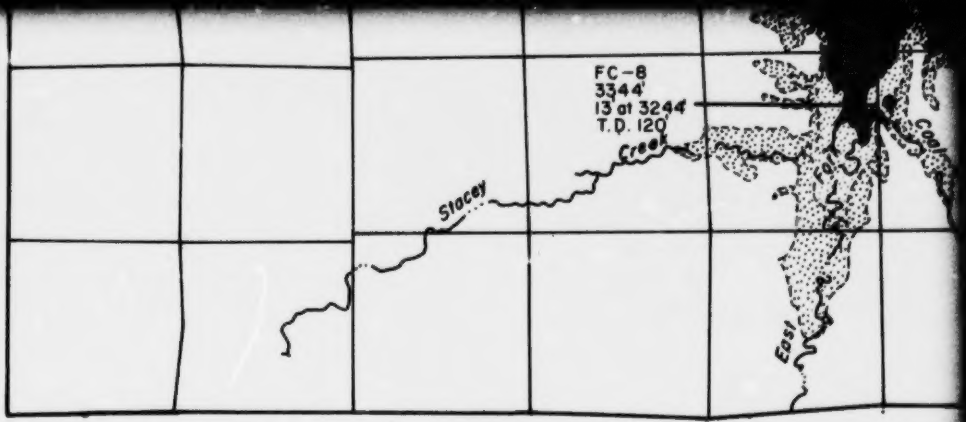
POSIT

LOCK COAL BED,
ES, MONTANA

N.P. and M.B.M.G. drill hole
hole designation
altitude at top of collar
altitude at top of 13' of coal
total depth of drill hole
Coal mine
Fault: dashed where inferred
Cross section A-A'
T.D. 120'
Dry
Creek
Little
Pumpkin
Creek
Pumpkin
Little
Creek
Creek
Cottonwood
Creek
Creek
FC-19
3139'
Trace Coal
T.D. 100'
FC-7
3352'
14 at 3259'
T.D. 110'
3244'
120
East
Fork
Coal
Creek
FC-6
3359'
11 at 3311'
T.D. 134'
FC-5
3357'
14 at 3298'
T.D. 80'
FC-4
3215'
Trace Coal
T.D. 280'
FC-1
3282'
13 at 3234'
T.D. 90'
FC-2
3282'
18 at 3213'
T.D. 110'
PC-30
FC-3
3290'
16 at 3183'
T.D. 140'
U
D
U
D
D
U


Little
Powder
Creek
Cottonwood
Creek
Pumpkin
Creek
FC-19
3139'
Trace Coal
T.D. 100
FC-6
3359'
11 at 3311'
T.D. 134'
FC-5
3357'
14' at 3298'
T.D. 80'
FC-4
3215'
Trace Coal
T.D. 280
FC-1
3282'
13 at 3234'
T.D. 90'
FC-2
3282'
18 at 3213'
T.D. 110'
PC-30
U D
D U
T. 1 S.
T. 2 S.


CROSS SECTION
I
FC-19
FC-5
FC-4
FC-1
FC-2
KNOBLOCK BED
FLOWERS-GOODALE BED
TERRET BED
14'
13'
18'



MAP OF

FOSTER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCK COAL BED, CUSTER AND POWDER RIVER COUNTIES, MONTANA

SCALE

0 1/2 1 2 Miles

DATUM IS MEAN SEA LEVEL

EXPLANATION

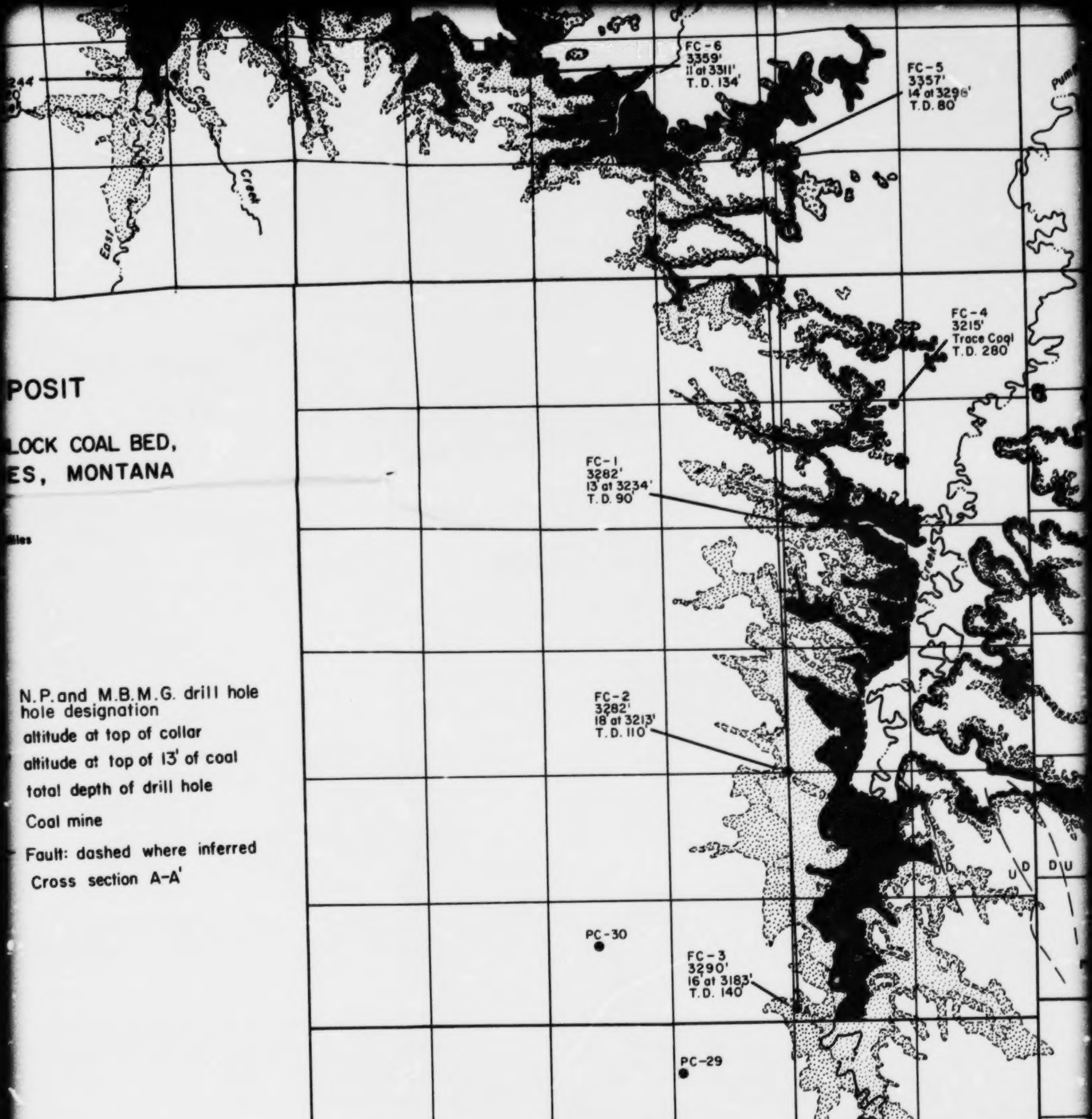
- - - - -	Knoblock coal bed	
▨	Clinker	
■	0 - 60'	overbuden
☐	60'- 90'	"
▨	90'-120'	"

● FC-8	N.P. and M.B.M.G. drill h hole designation
3344'	altitude at top of collar
13' at 3244'	altitude at top of 13' of coal
T.D. 120'	total depth of drill hole
⚒	Coal mine
—D/U—	Fault: dashed where inferr
A—A'	Cross section A-A'

N

Section and township grid adapted from 1:31,680 scale U.S. Forest Service planimetric quadrangle map and U.S. Government survey plats; geologic interpretation, drainage, and culture from A.S.C.S. 1:20,000 scale aerial photography.

8



244
East
Fork
Coal
Creek
FC-6
3359'
11' at 3311'
T.D. 134'
FC-5
3357'
14' at 3296'
T.D. 80'
Pump
FC-4
3215'
Trace Coal
T.D. 280'
FC-1
3282'
13' at 3234'
T.D. 90'
Creek
FC-2
3282'
18' at 3213'
T.D. 110'
U
D
U
D
D
U
PC-30
FC-3
3290'
16' at 3183'
T.D. 140'
PC-29

POSIT

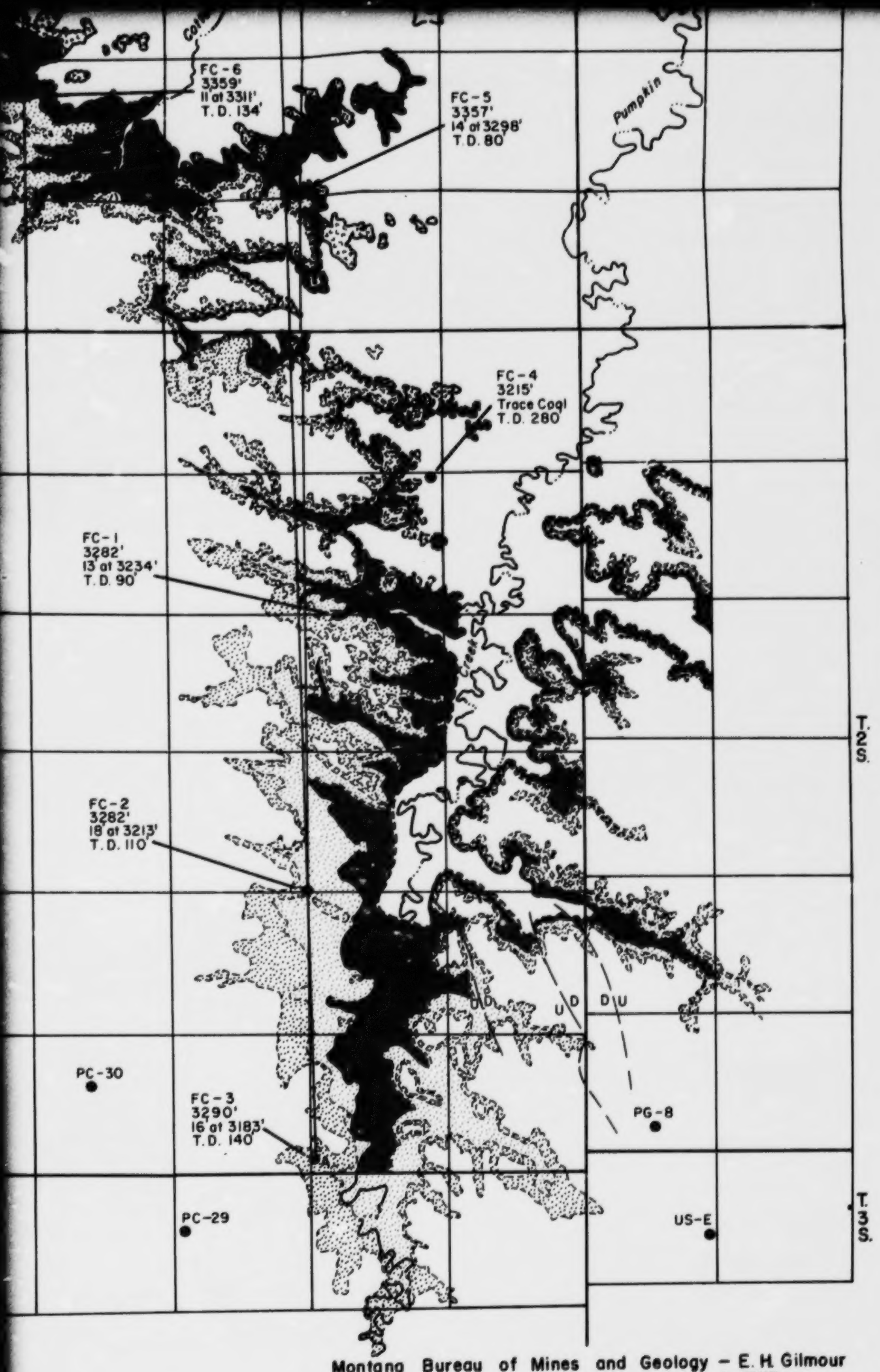
LOCK COAL BED,
ES, MONTANA

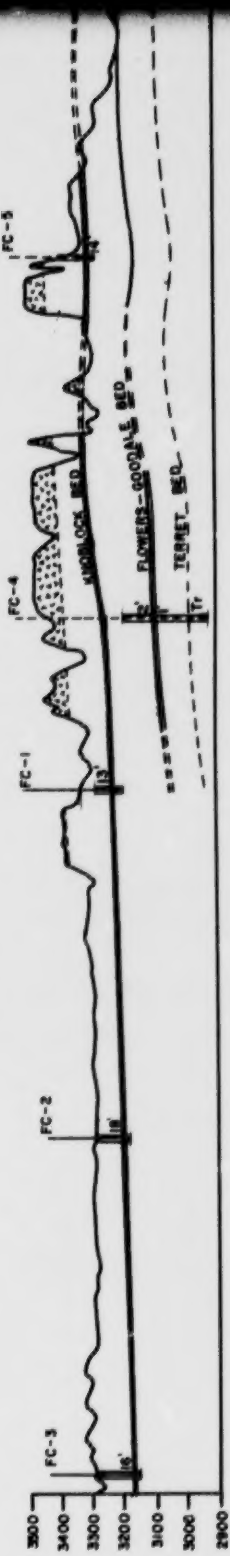
Miles

N.P. and M.B.M.G. drill hole
hole designation
altitude at top of collar
altitude at top of 13' of coal
total depth of drill hole
Coal mine
Fault: dashed where inferred
Cross section A-A'

Montana Bureau of Mines and
Northern Pacific Railway Compa
Draftsman — M. J. Daniels

K

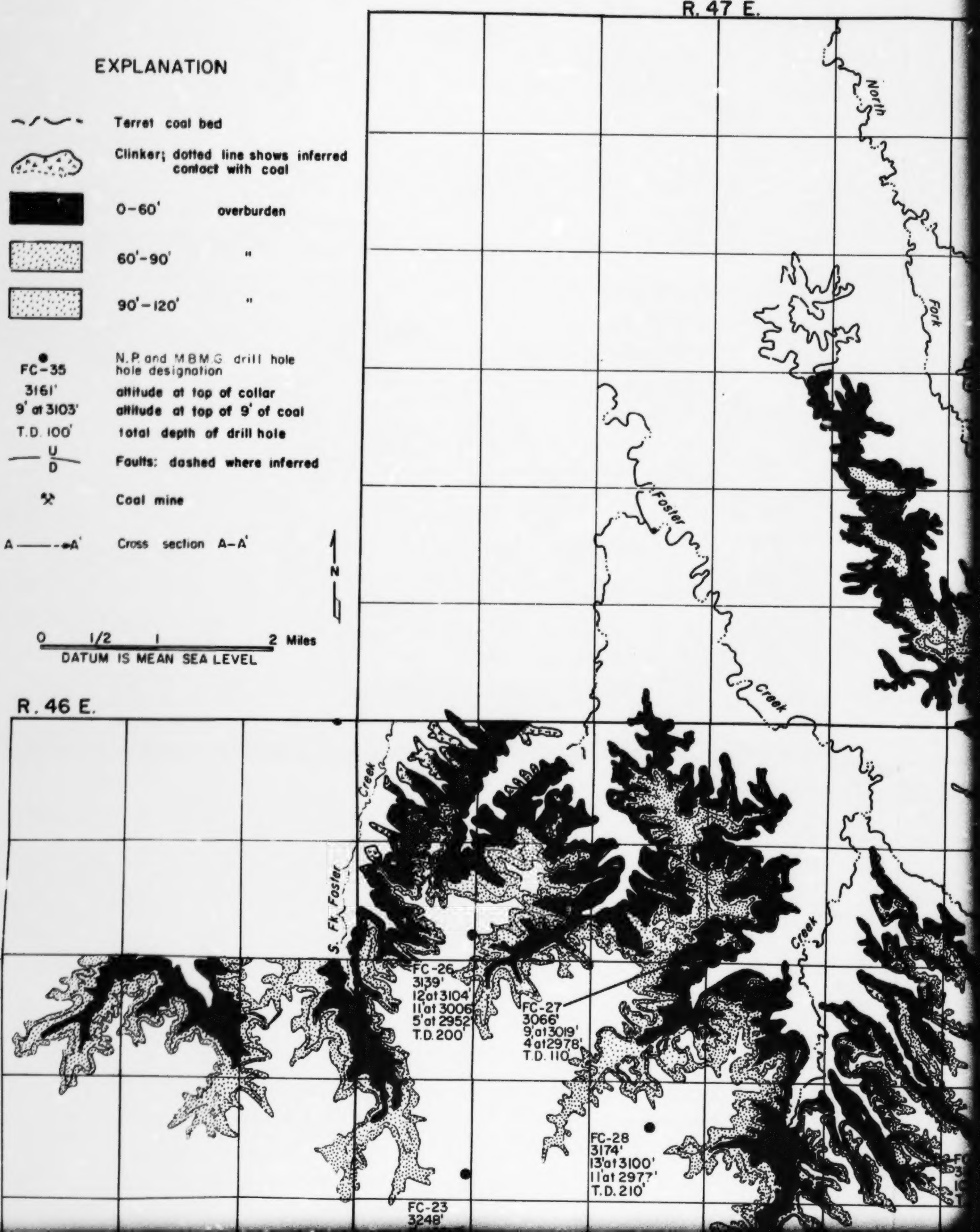

Coal
FC-6
3359'
11 at 3311'
T.D. 134'
FC-5
3357'
14 at 3298'
T.D. 80'
Pumpkin
FC-4
3215'
Trace Coal
T.D. 280'
FC-1
3282'
13 at 3234'
T.D. 90'
Creek
T.
2
S.
FC-2
3282'
18' at 3213'
T.D. 110'
D
U D
D U
PC-30
FC-3
3290'
16 at 3183'
T.D. 140
PG-8
PC-29
US-E
T.
3
S.

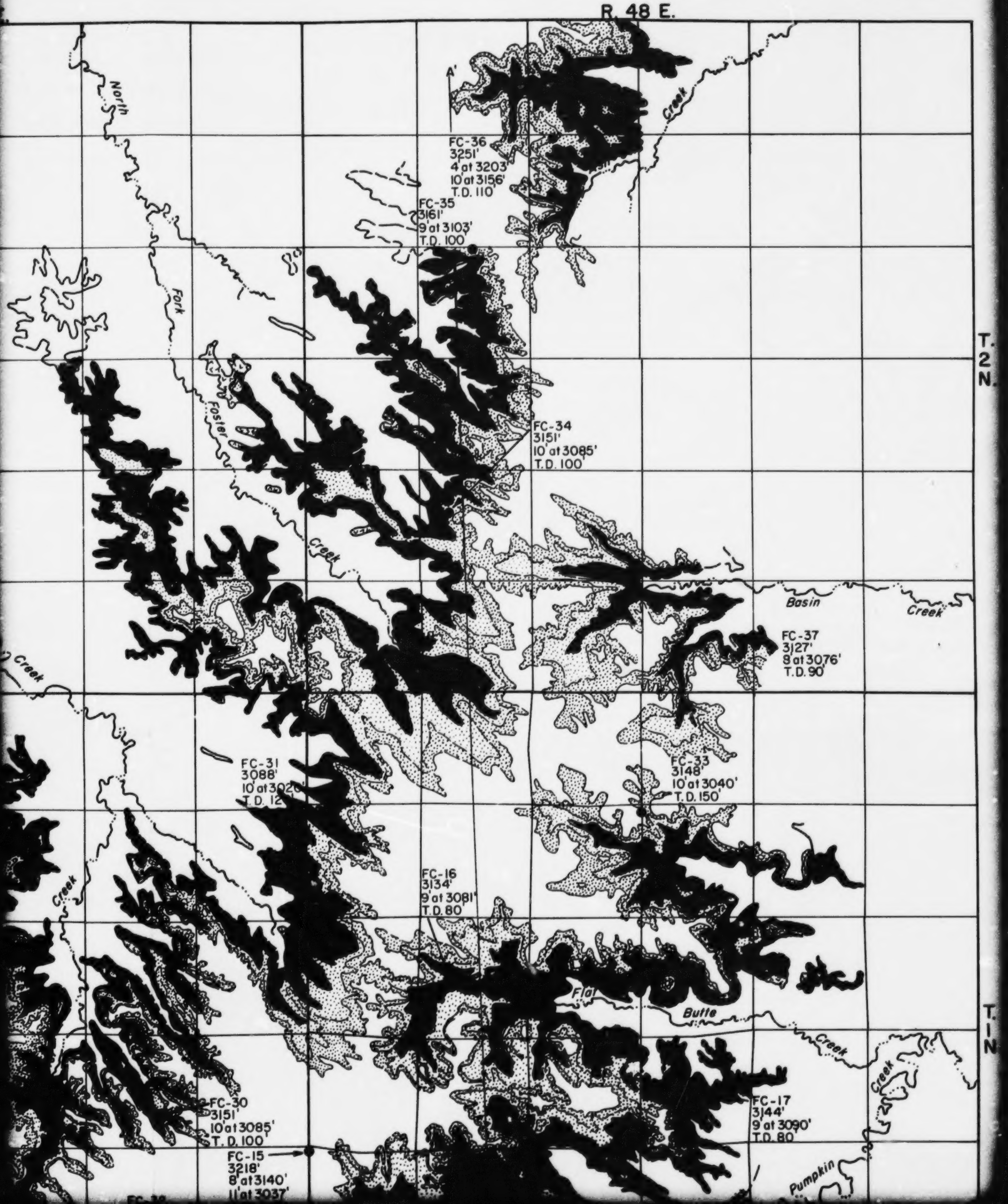

FC-5
FC-4
FC-1
FC-2
FC-3
14'
13'
18'
16'
12'
Tr
KNOBLOCK BED
FLOWERS-GOODALE BED
TERRET BED
3500
3400
3300
3200
3100
3000
2900

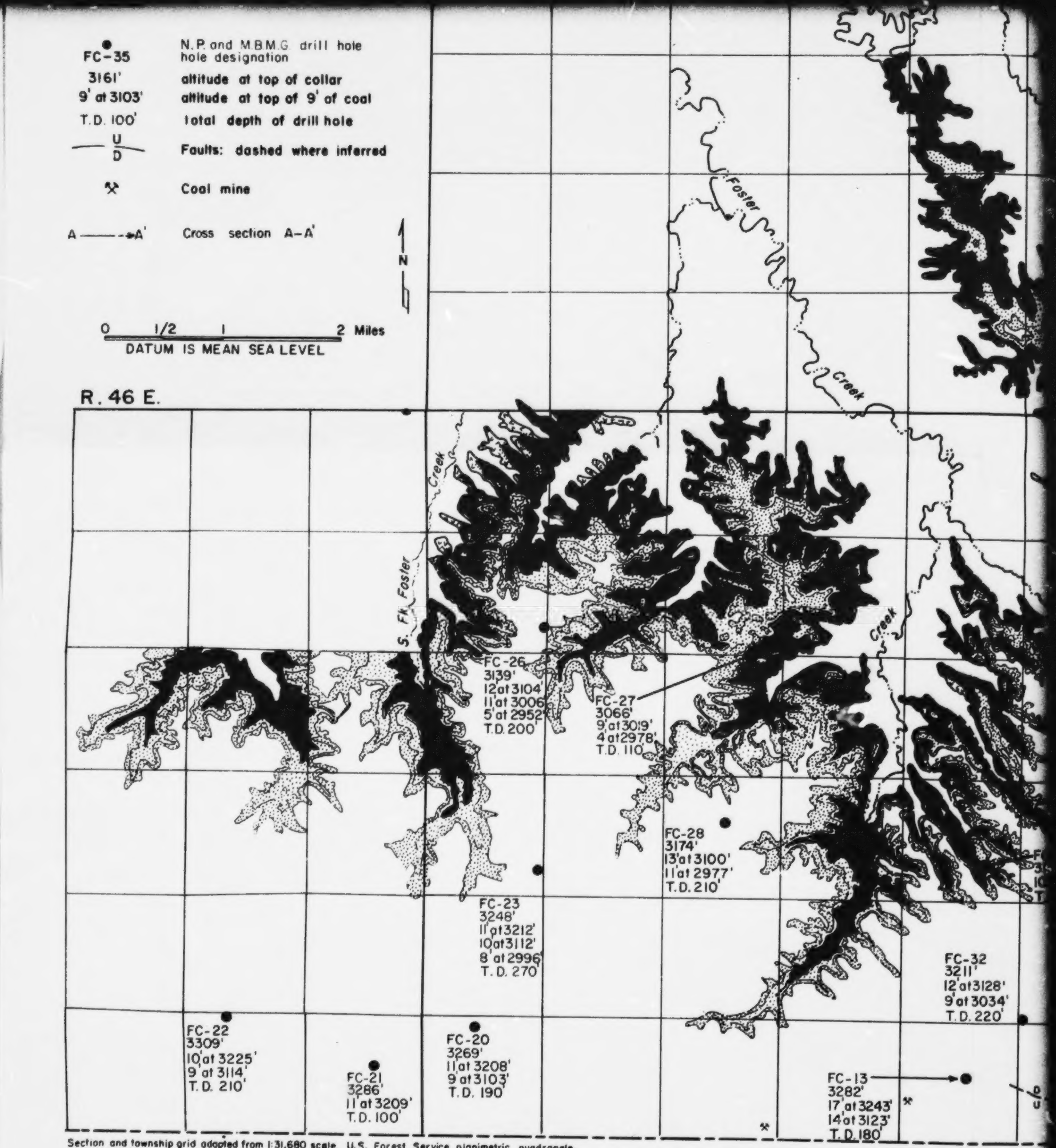
Montana Bureau of Mines and Geology – E. H. Gilmour
Northern Pacific Railway Company – L. A. Williams
Draftsman – M. J. Daniels

L

A MONTANA BUREAU OF MINES AND GEOLOGY


R. 47 E.
EXPLANATION
Terret coal bed
Clinker; dotted line shows inferred contact with coal
0-60' overburden
60'-90' "
90'-120' "
FC-35 N.P. and M.B.M.G. drill hole hole designation
3161' altitude at top of collar
9' at 3103' altitude at top of 9' of coal
T.D. 100' total depth of drill hole
U D Faults: dashed where inferred
Coal mine
A —— A' Cross section A-A'
N
0 1/2 1 2 Miles
DATUM IS MEAN SEA LEVEL
R. 46 E.
North Fork
Foster Creek
S. Fk. Foster Creek
Creek
FC-26
3139'
12 at 3104'
11 at 3006'
5 at 2952'
T.D. 200'
FC-27
3066'
9 at 3019'
4 at 2978'
T.D. 110
FC-28
3174'
13' at 3100'
11' at 2977'
T.D. 210'
FC-23
3248'


R. 48 E.
A'
North
Fork
Foster
Creek
Creek
Creek
Creek
Basin
Creek
Flat
Butte
Creek
Creek
Pumpkin
T. 2 N.
T. 1 N.
FC-36
3251'
4' at 3203'
10' at 3156'
T.D. 110
FC-35
3161'
9' at 3103'
T.D. 100'
FC-34
3151'
10' at 3085'
T.D. 100'
FC-37
3127'
8' at 3076'
T.D. 90'
FC-31
3088'
10' at 3020'
T.D. 12
FC-33
3148'
10' at 3040'
T.D. 150'
FC-16
3134'
9' at 3081'
T.D. 80'
FC-30
3151'
10' at 3085'
T.D. 100'
FC-17
3144'
9' at 3090'
T.D. 80
FC-15
3218'
8' at 3140'
11' at 3037'
FC-30


FC-35
N.P. and M.B.M.G. drill hole hole designation
3161'
altitude at top of collar
9' at 3103'
altitude at top of 9' of coal
T.D. 100'
total depth of drill hole
U
D
Faults: dashed where inferred
Coal mine
A → A'
Cross section A-A'
N
0 1/2 1 2 Miles
DATUM IS MEAN SEA LEVEL
R. 46 E.
Foster
Creek
S. Fk. Foster
Creek
Creek
FC-26
3139'
12'at 3104'
11'at 3006'
5'at 2952'
T.D. 200'
FC-27
3066'
9'at 3019'
4'at 2978'
T.D. 110'
FC-28
3174'
13'at 3100'
11'at 2977'
T.D. 210'
FC-23
3248'
11'at 3212'
10'at 3112'
8' at 2996'
T. D. 270'
FC-32
3211'
12'at 3128'
9'at 3034'
T.D. 220'
FC-22
3309'
10'at 3225'
9' at 3114'
T. D. 210'
FC-21
3286'
11'at 3209'
T.D. 100'
FC-20
3269'
11'at 3208'
9'at 3103'
T. D. 190'
FC-13
3282'
17'at 3243'
14'at 3123'
T. D. 180'

Section and township grid adapted from 1:31,680 scale U.S. Forest Service planimetric quadrangle map and U.S. Government survey plats; geologic interpretation, drainage, and culture from A.S.C.S. 1:20,000 scale aerial photography.

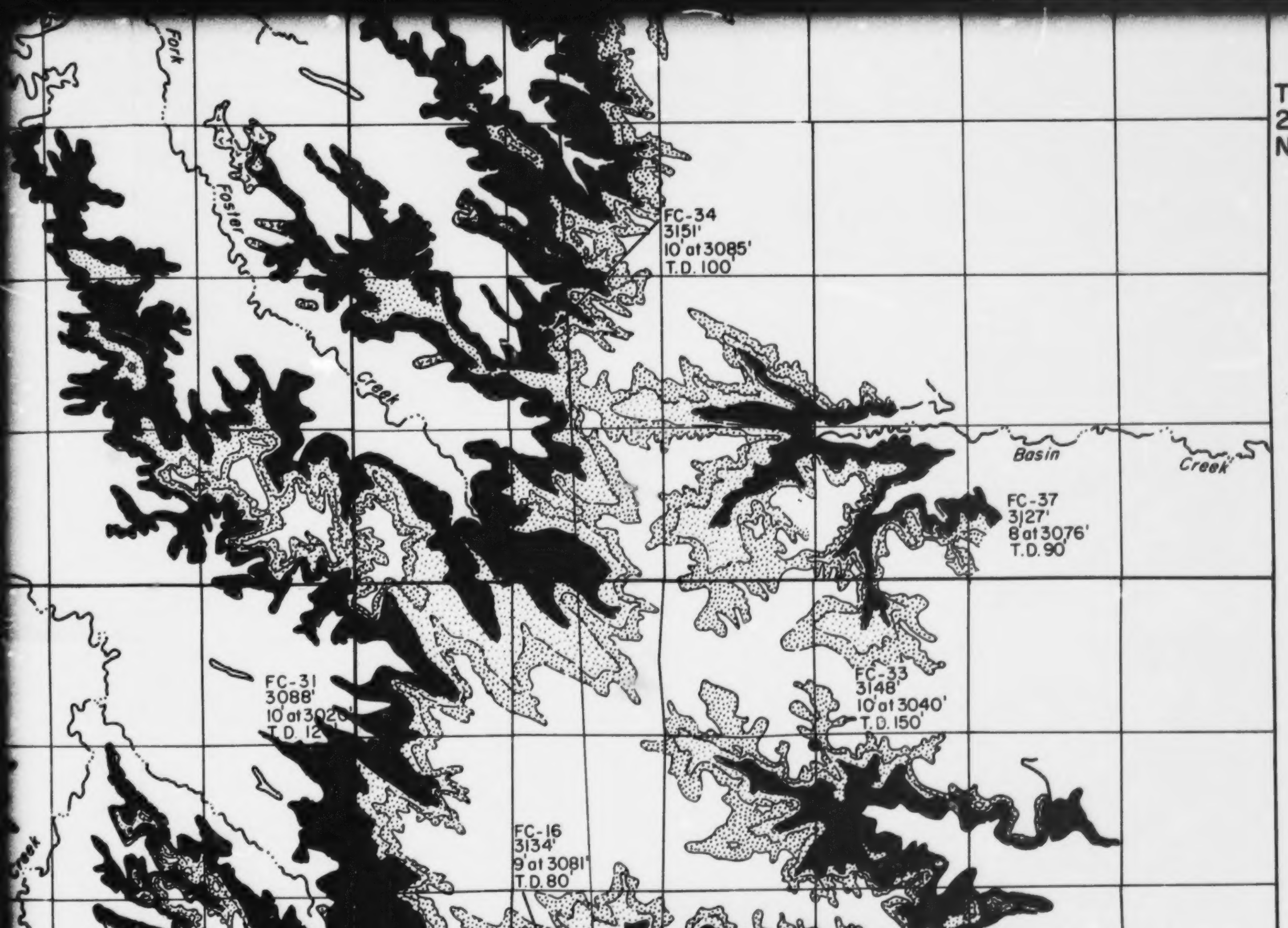
MAP OF

FOSTER CREEK COAL

SHOWING

STRIPPABLE RESERVES IN THE TE
CUSTER COUNTY, MON

C


Fork
Foster
Creek
T. 2 N.
FC-34
3151'
10' at 3085'
T.D. 100'
Basin
Creek
FC-37
3127'
8' at 3076'
T.D. 90'
FC-31
3088'
10' at 3020'
T.D. 12
FC-33
3148'
10' at 3040'
T.D. 150'
Creek
FC-16
3134'
9' at 3081'
T.D. 80'
Flat
Butte
Creek
T. 1 N.
Creek
FC-30
3151'
10' at 3085'
T.D. 100'
FC-17
3144'
9' at 3090'
T.D. 80'
FC-15
3218'
8' at 3140'
11' at 3037'
T.D. 210'
Pumpkin
FC-32
3211'
12' at 3128'
9' at 3034'
T.D. 220'
Creek
Bed >6' thick
Bed <6' thick
Tree
FC-14
3231'
12' at 3160'
5' at 3145'
7' at 3052'
T.D. 190'
D
U
U
D
FC-18
3163'
trace coal
T.D. 170'
A
243'
123'

Montana Bureau of Mines and Geology — E.H. Gilmour
Northern Pacific Railway Company — L. A. Williams
Draftsman — M. J. Daniels

MAP OF

CREEK COAL DEPOSIT

SHOWING

SERVES IN THE TERRET COAL BED,
TER COUNTY, MONTANA

D

MONTANA BUREAU OF MINES AND GEOLOGY

EXPLANATION

〰 Flowers-Goodale coal outcrop

▨ Clinker; dotted line shows inferred contact with coal

■ 0'-60' overburden

▨ 60'-90' "

▨ 90'-120' "

● N. P. and M.B.M.G. drill hole

FC-31	hole designation
3088'	altitude at top of collar
10' at 3020	altitude at top of 10' of coal
T. D. 120'	total depth of hole

U/D - - - Fault; dashed where inferred

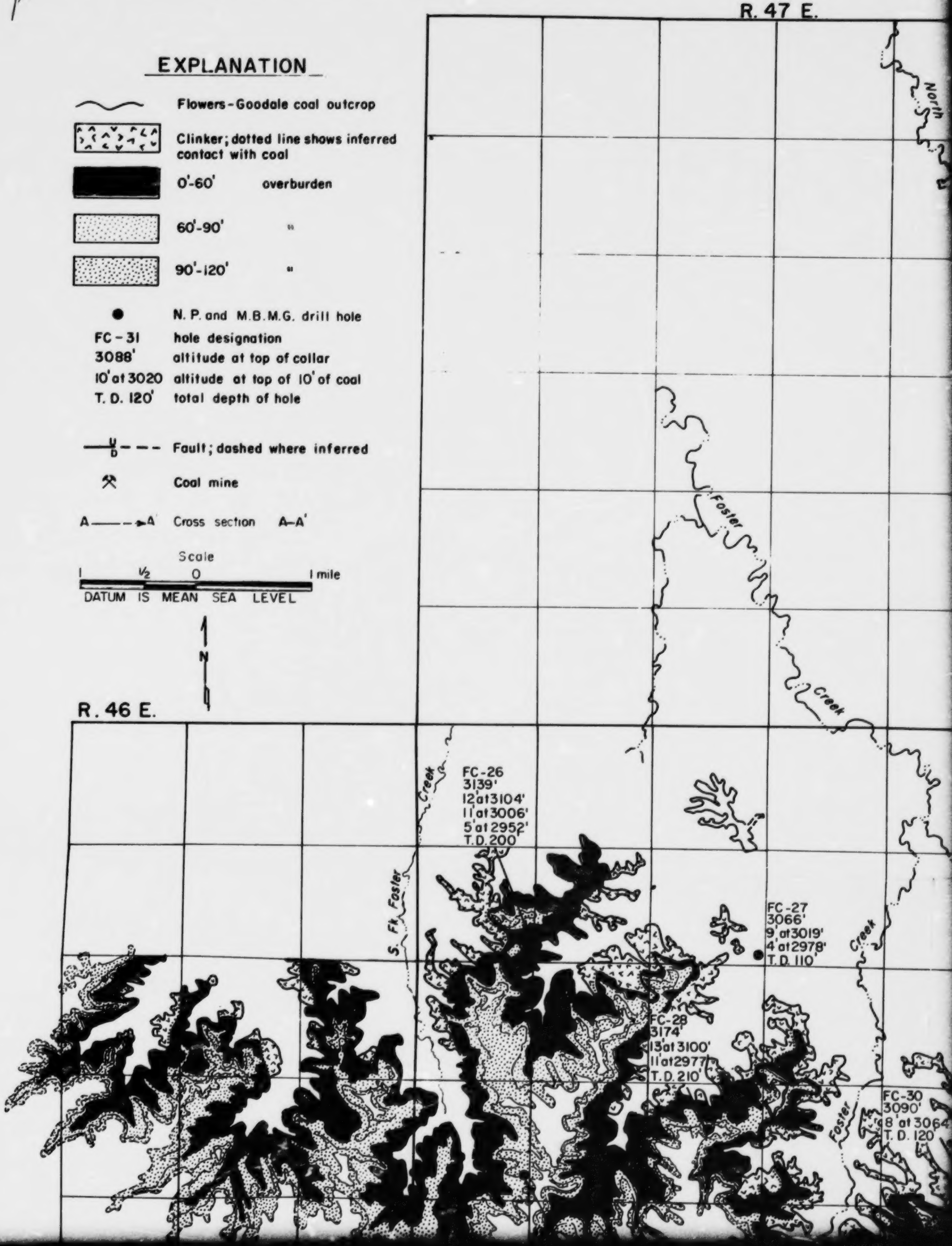
⚒ Coal mine

A ——→ A' Cross section A—A'

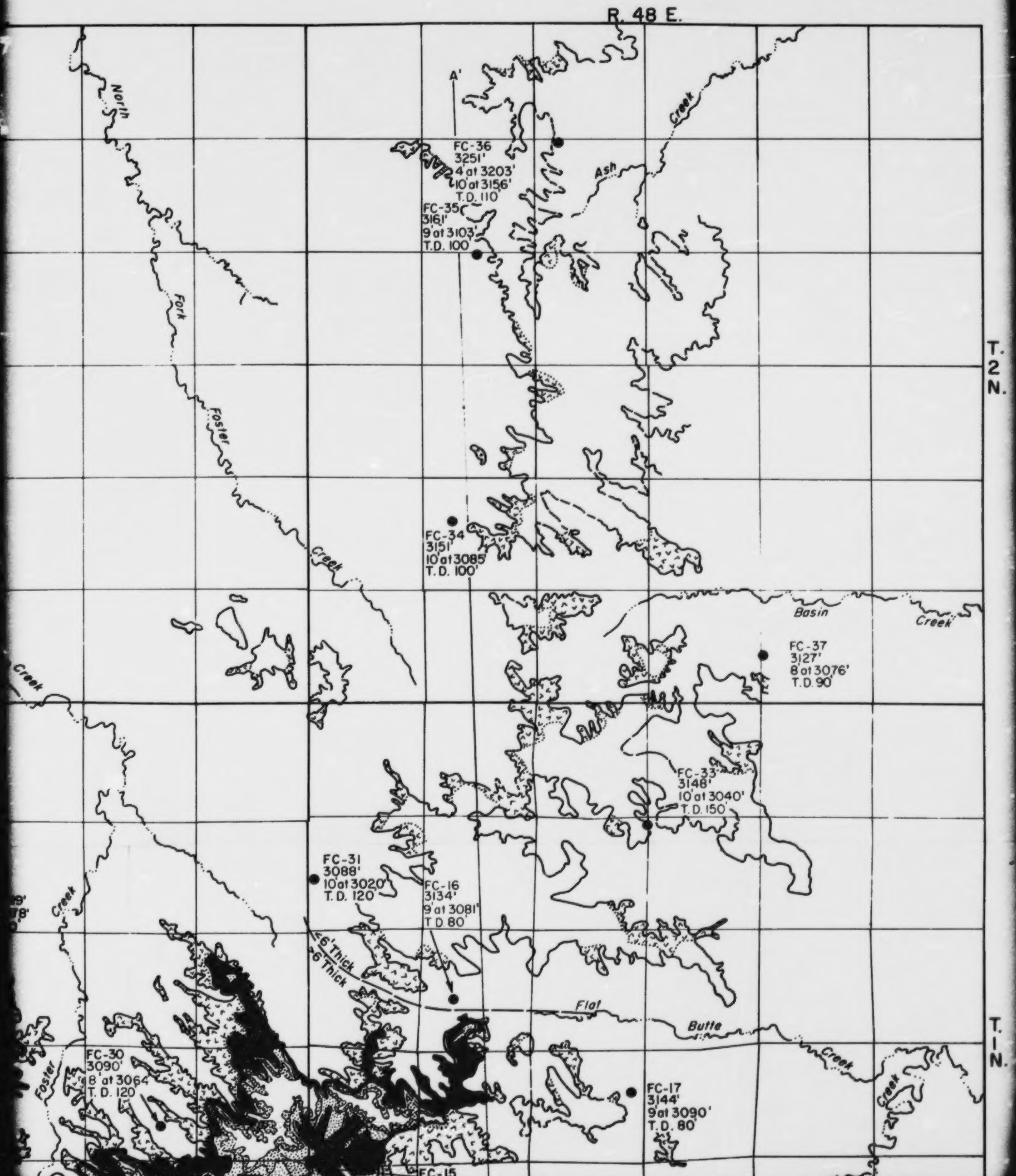
Scale

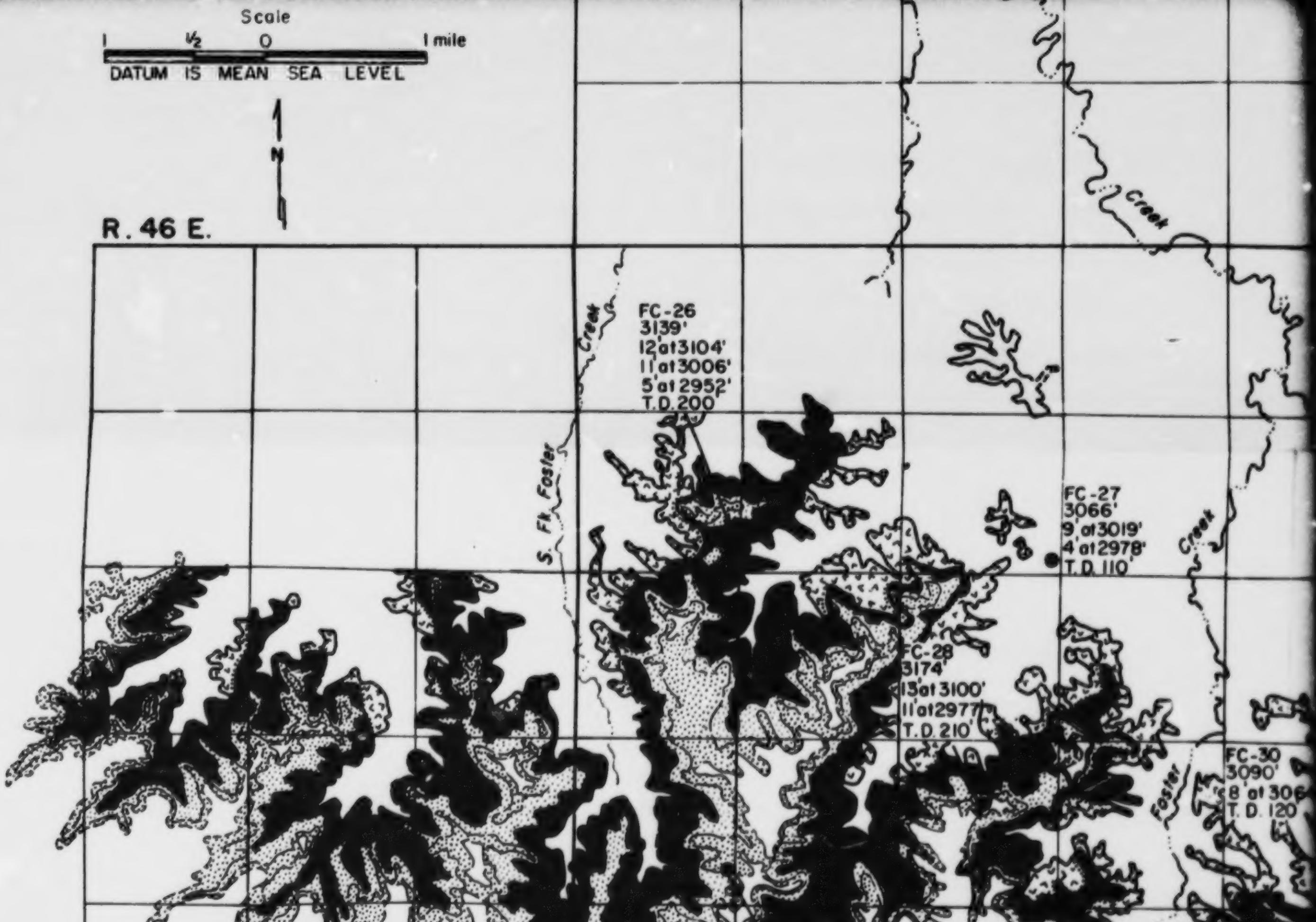
1 ½ 0 1 mile

DATUM IS MEAN SEA LEVEL


R. 47 E.
North
Foster
Creek
R. 46 E.
Creek
S. Fk. Foster
FC-26
3139'
12' at 3104'
11' at 3006'
5' at 2952'
T.D. 200
FC-27
3066'
9' at 3019'
4' at 2978'
T.D. 110'
Creek
FC-28
3174'
13' at 3100'
11' at 2977
T.D. 210'
FC-30
3090'
8' at 3064
T. D. 120
Foster
Creek
N

BULLETIN 91 PLATE 16 C


R. 48 E.
T. 2 N.
T. 1 N.
A'
North Fork Foster Creek
Ash Creek
Basin Creek
Flat Butte Creek
Foster Creek
Creek
FC-36
3251'
4' at 3203'
10' at 3156'
T.D. 110'
FC-35
3161'
9' at 3103'
T.D. 100'
FC-34
3151'
10' at 3085'
T.D. 100'
FC-37
3127'
8' at 3076'
T.D. 90'
FC-33
3148'
10' at 3040'
T.D. 150'
FC-31
3088'
10' at 3020'
T.D. 120
FC-16
3134'
9' at 3081'
T.D. 80'
6' Thick
6' Thick
FC-30
3090'
8' at 3064
T.D. 120
FC-17
3144'
9' at 3090'
T.D. 80'
FC-15
3218'
29'
78'

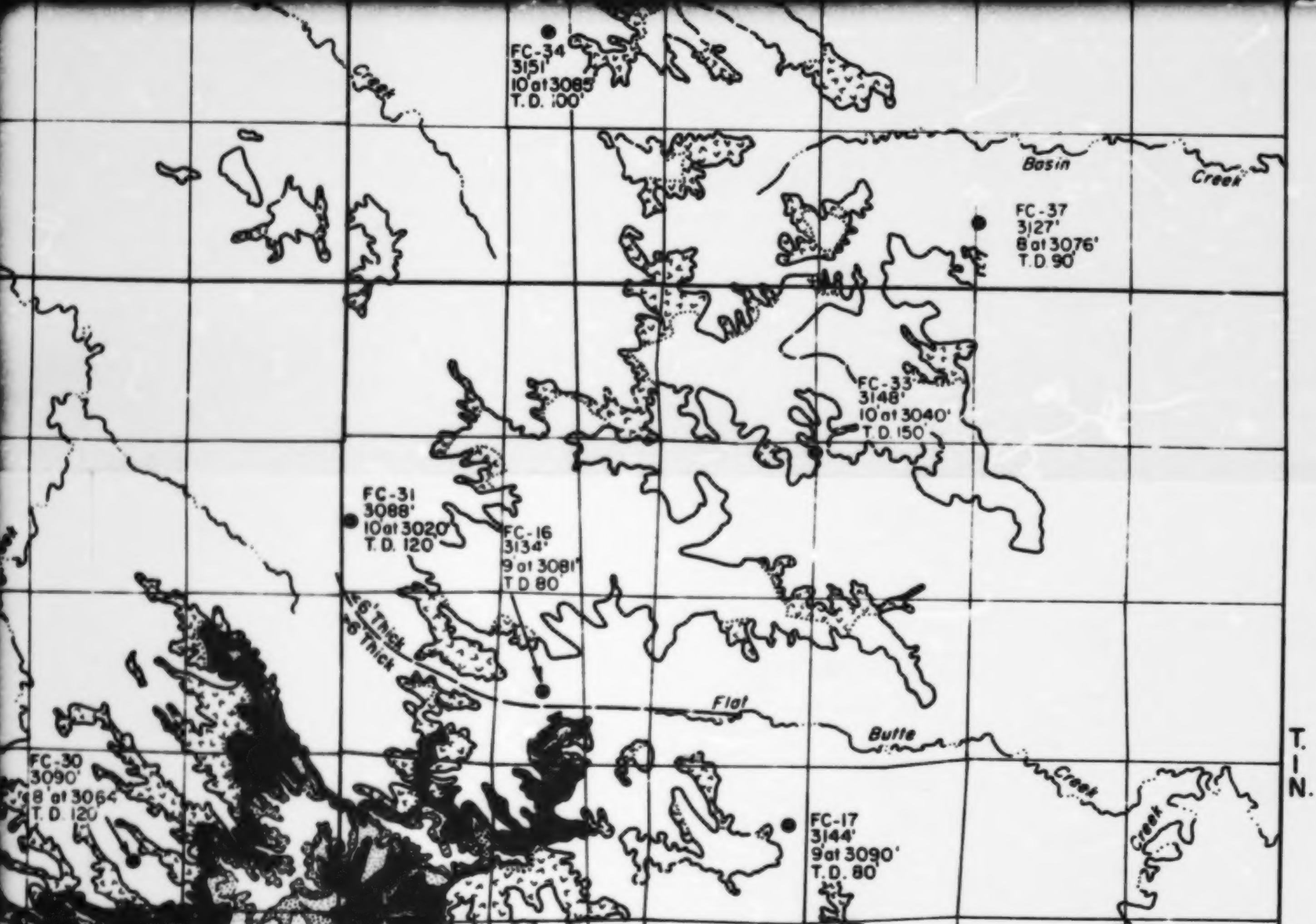

Scale
1 1/2 0 1 mile
DATUM IS MEAN SEA LEVEL
N
R. 46 E.
Creek
Creek
S. Fk. Foster
Creek
Foster
Dry
Creek
FC-26
3139'
12 at 3104'
11 at 3006'
5 at 2952'
T.D. 200
FC-27
3066'
9 at 3019'
4 at 2978'
T.D. 110'
FC-28
3174'
13 at 3100'
11 at 2977'
T.D. 210'
FC-30
3090'
8 at 306
T. D. 120
FC-23
3248'
11 at 3212'
10 at 3112'
8 at 2996'
T.D. 270
FC-22
3309'
10 at 3225'
9 at 3114'
T.D. 210'
FC-21
3286'
11 at 32C9'
T.D. 100
FC-20
3269'
11 at 3208'
9 at 3103'
T.D. 190
FC-13
3282'
17 at 3243'
14 at 3123'
T.D. 180
FC-12
3352'
15 at 3258'
T.D. 120'
FC-11
3352'
16 at 3268'
8 at 3140'
T.D. 221'

Section and township grid adapted from 1:31,680 scale U.S. Forest Service planimetric quadrangle maps and U.S. Government survey plats: geologic interpretation, drainage, and culture from A.S.C.S. 1:20,000 scale aerial photography.

FOSTER CREE

STRIPPABLE RESERVES IN T
CUSTER AND POWDER

C


FC-34
3151'
10 at 3085'
T.D. 100'
Creek
Basin
Creek
FC-37
3127'
8 at 3076'
T.D 90'
FC-33
3148'
10 at 3040'
T.D. 150'
FC-31
3088'
10 at 3020'
T.D. 120'
FC-16
3134'
9 at 3081'
T.D 80'
6' Thick
6' Thick
Flat
Butte
Creek
T.
1
N.
FC-30
3090'
8 at 3064'
T.D. 120'
FC-17
3144'
9 at 3090'
T.D. 80'
Creek
FC-15
3218'
8 at 3140'
11 at 3037'
T.D. 210
Pumpkin
FC-32
3211'
12 at 3128'
9 at 3034'
T.D. 220'
Lone
Tree
Creek
FC-14
3231'
12 at 3160'
5 at 3145'
7 at 3052'
T.D. 190'
FC-18
3163'
trace coal
T.D. 170'
CUSTER CO.
POWDER RIVER CO.
Creek
T.
1
S.
limit of data
Creek
Little
Pumpkin
A

MAP OF

R CREEK COAL DEPOSIT

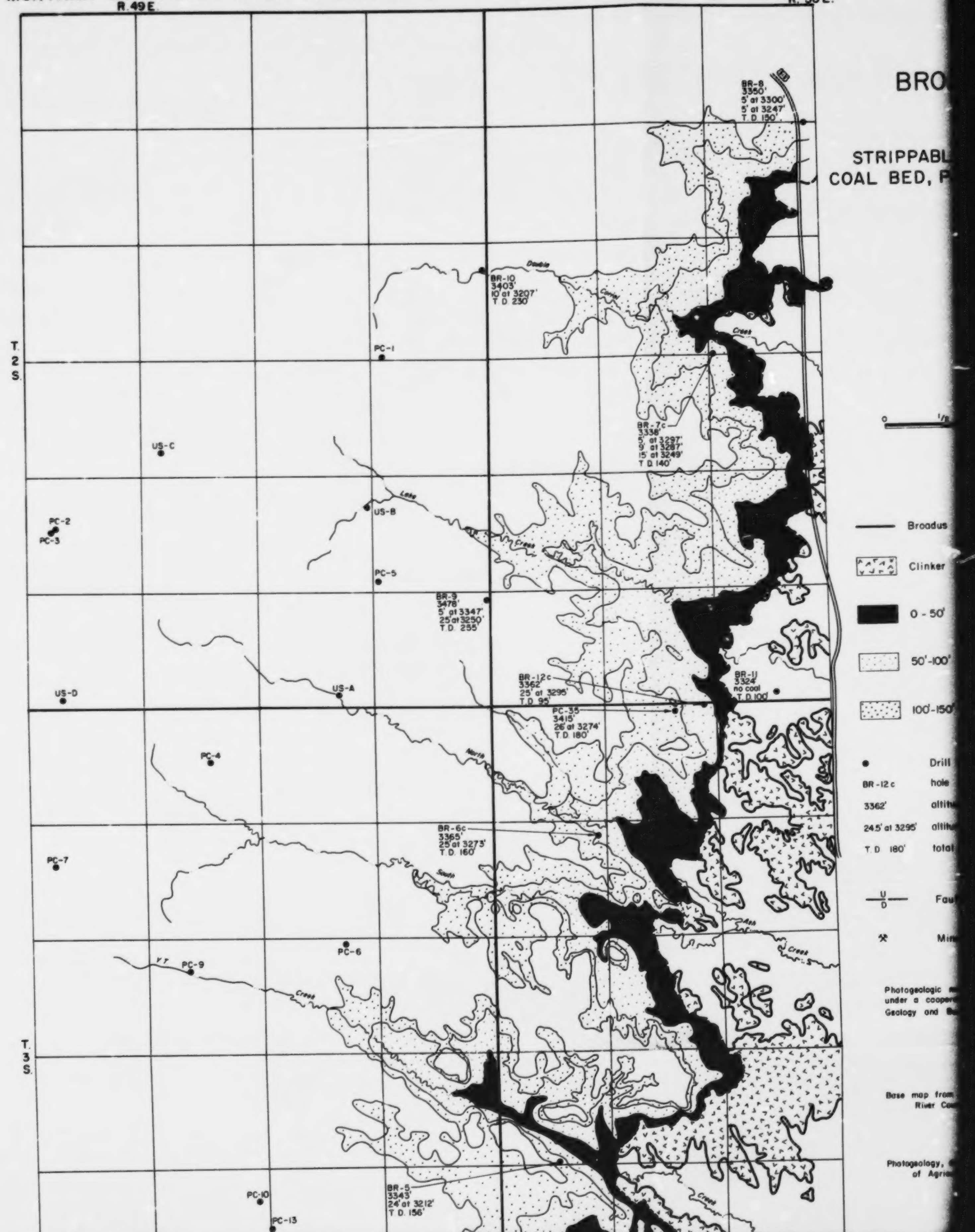
SHOWING

S IN THE FLOWERS-GOODALE COAL BED,
OWDER RIVER COUNTIES, MONTANA

Montana Bureau of Mines and Geology — E. H. Gilmour
Northern Pacific Railway Company — L. A. Williams
Draftsman — M. J. Daniels

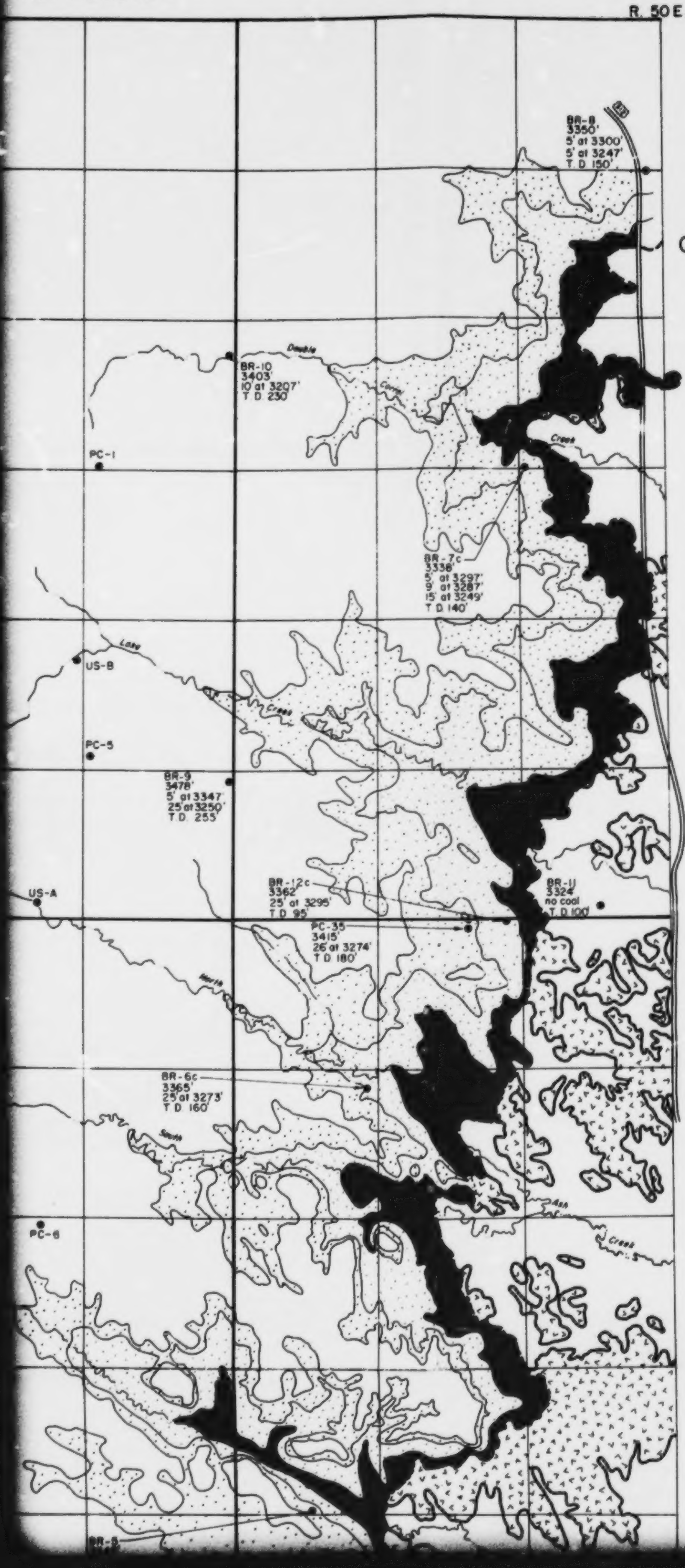
D

A MONTANA BUREAU OF MINES AND GEOLOGY



R. 49 E.
R. 50 E.
BRO
STRIPPABL
COAL BED, P
T. 2 S.
T. 3 S.
BR-8
3350'
5' at 3300'
5' at 3247'
T.D. 150'
BR-10
3403'
10 at 3207'
T.D. 230'
Double
Crow
Creek
PC-1
BR-7c
3338'
5' at 3297'
9' at 3287'
15' at 3249'
T.D. 140'
US-C
US-B
Lone
Creek
PC-2
PC-3
PC-5
BR-9
3478'
5' at 3347'
25' at 3250'
T.D. 255'
BR-12c
3362'
25' at 3295'
T.D. 95'
BR-11
3324'
no coal
T.D. 100'
US-D
US-A
PC-35
3415'
26' at 3274'
T.D. 180'
PC-4
North
BR-6c
3365'
25' at 3273'
T.D. 160'
PC-7
South
Ash
Creek
PC-6
PC-9
Creek
BR-5
3343'
24' at 3212'
T.D. 156'
PC-10
PC-13
Creek
0
1/2
Broadus
Clinker
0 - 50'
50'-100'
100'-150'
Drill
BR-12c hole
3362' altitu
24.5' at 3295' altitu
T.D. 180' total
U
D
Fau
Min
Photogeologic m
under a cooper
Geology and B
Base map from
River Co
Photogeology,
of Agric

B


R. 50 E.
BR-8
3350'
5' at 3300'
5' at 3247'
T.D. 150'
BR-10
3403'
10' at 3207'
T.D. 230'
Double
Corral
Creek
PC-1
BR-7c
3338'
5' at 3297'
9' at 3287'
15' at 3249'
T.D. 140'
US-B
Lone
Creek
PC-5
BR-9
3478'
5' at 3347'
25' at 3250'
T.D. 255'
US-A
BR-12c
3362'
25' at 3295'
T.D. 95'
BR-11
3324'
no coal
T.D. 100'
PC-35
3415'
26' at 3274'
T.D. 180'
North
BR-6c
3365'
25' at 3273'
T.D. 160'
South
Ash
Creek
PC-6
BR-5

MAP OF

BROADUS COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE BROADUS COAL BED, POWDER RIVER COUNTY, MONTANA

N

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

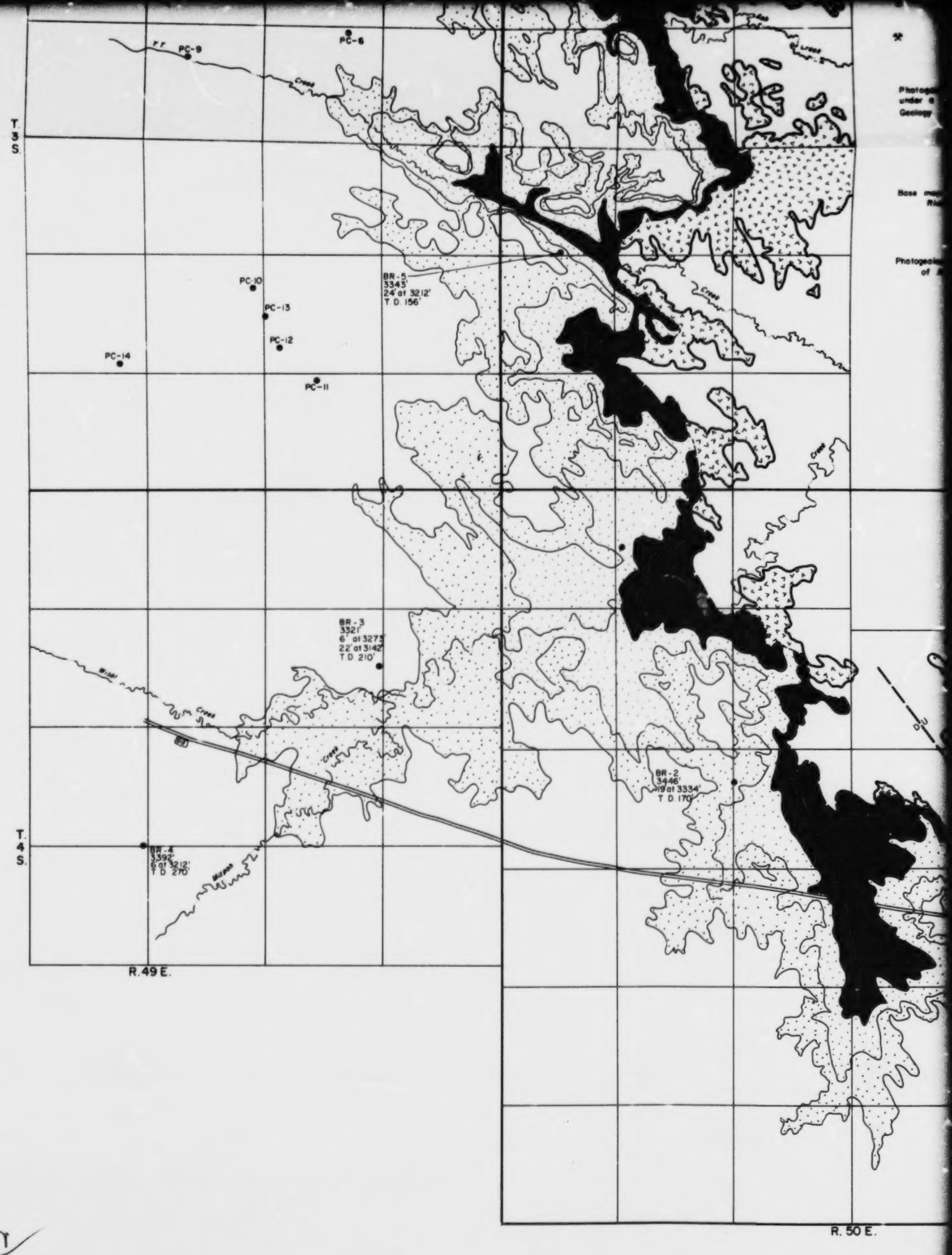
—	Broadus coal bed
▨	Clinker
■	0 - 50' of overburden
░	50'-100' " "
▒	100'-150' " "
●	Drill hole
BR-12c	hole designation (c indicates coal core recovered)
3362'	altitude at top of collar
24.5' at 3295'	altitude at top of 24.5' of coal
T.D. 180'	total depth of drill hole
U/D	Fault
⚒	Mine

Photogeologic mapping, topographic control, and drilling program conducted under a cooperative agreement between the Montana Bureau of Mines and Geology and Burlington Northern Inc., 1967.

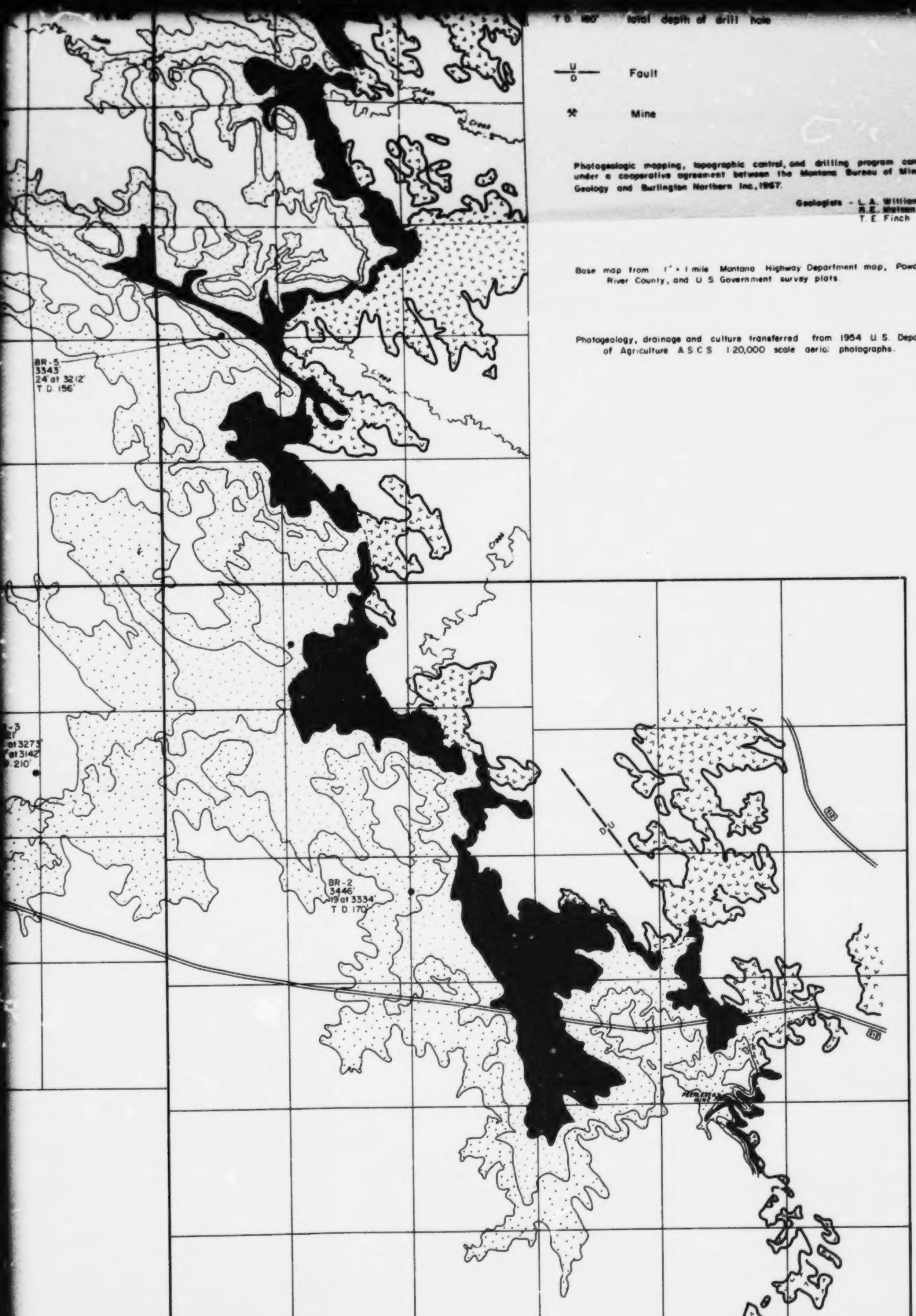
Geologists - L. A. Williams (B.N.)
R. E. Matson and
T. E. Finch (M.B.M.G.)

Base map from 1" = 1 mile Montana Highway Department map, Powder River County, and U.S. Government survey plats.

Photogeology, drainage and culture transferred from 1954 U.S. Department of Agriculture A.S.C.S 1:20,000 scale aerial photographs.


PC-9
PC-6
Creek
T. 3 S.
PC-10
PC-13
PC-12
PC-14
PC-11
BR-5
3343'
24' at 3212'
T D. 156'
Creek
Creek
BR-3
3321'
6' at 3273'
22' at 3142'
T D. 210'
Wibaux
Creek
Creek
Creek
BR-2
3446'
19' at 3334'
T D. 170'
T. 4 S.
BR-4
3392'
6' at 3212'
T D. 270'
Mispah
R. 49 E.
R. 50 E.
D
U
Photoge
under a
Geology
Base ma
Riv
Photogeolo
of

a✓


Creek
Creek
Creek
Creek
BR-5
3343'
24' at 3212'
T.D. 156'
-3
21'
at 3273'
at 3142'
210'
BR-2
3446'
19' at 3334'
T D 170'
D
U
212
212
R. 50 E.

T.D. 180' total depth of drill hole

U
D
Fault

⚒ Mine

Photogeologic mapping, topographic control, and drilling program conducted under a cooperative agreement between the Montana Bureau of Mines and Geology and Burlington Northern Inc., 1967.

Geologists - L.A. Williams (B.N.)
R.E. Matson and
T.E. Finch (M.B.M.G.)

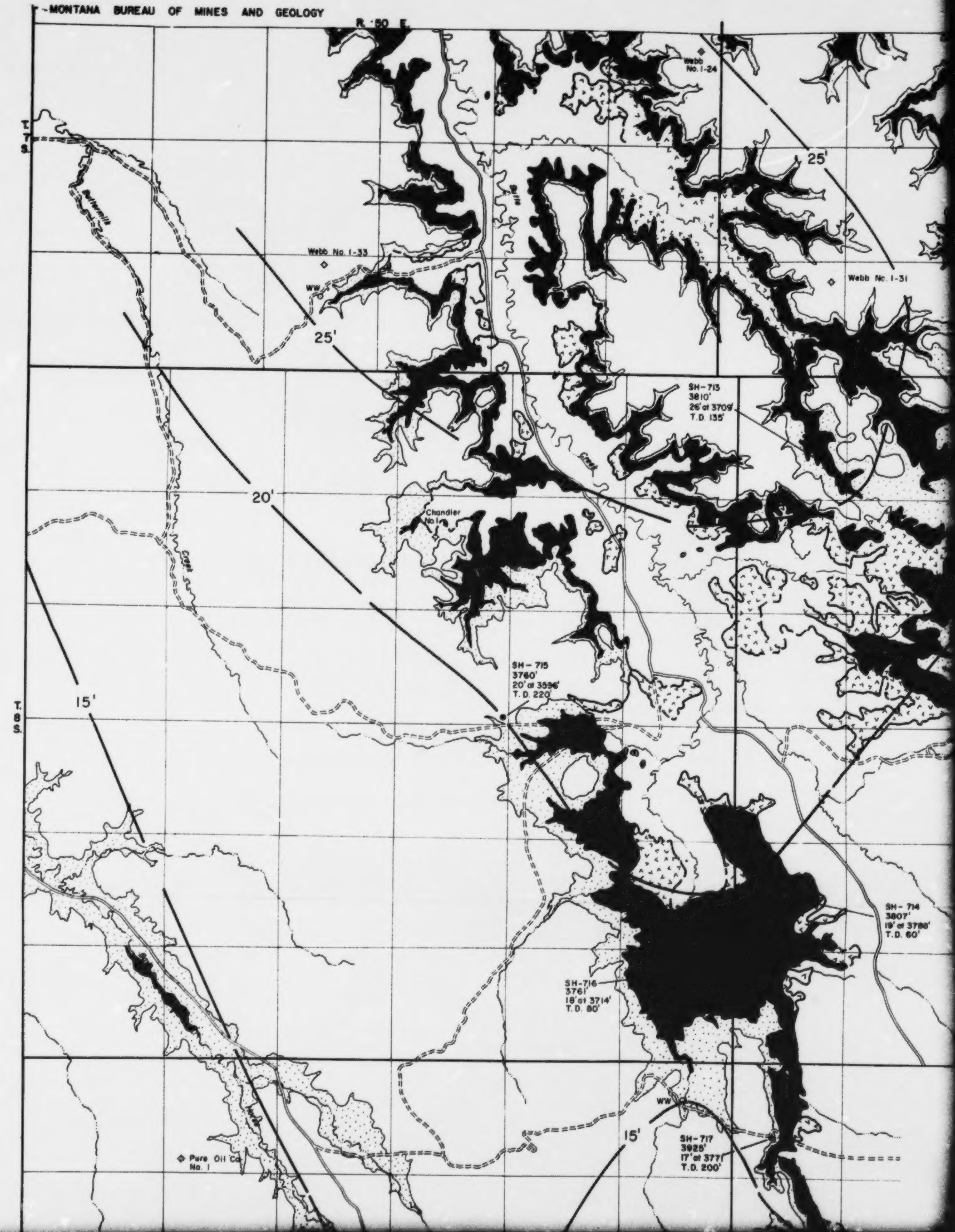
Base map from 1" = 1 mile Montana Highway Department map, Powder River County, and U.S. Government survey plats.

Photogeology, drainage and culture transferred from 1954 U.S. Department of Agriculture A.S.C.S. 1:20,000 scale aerial photographs.

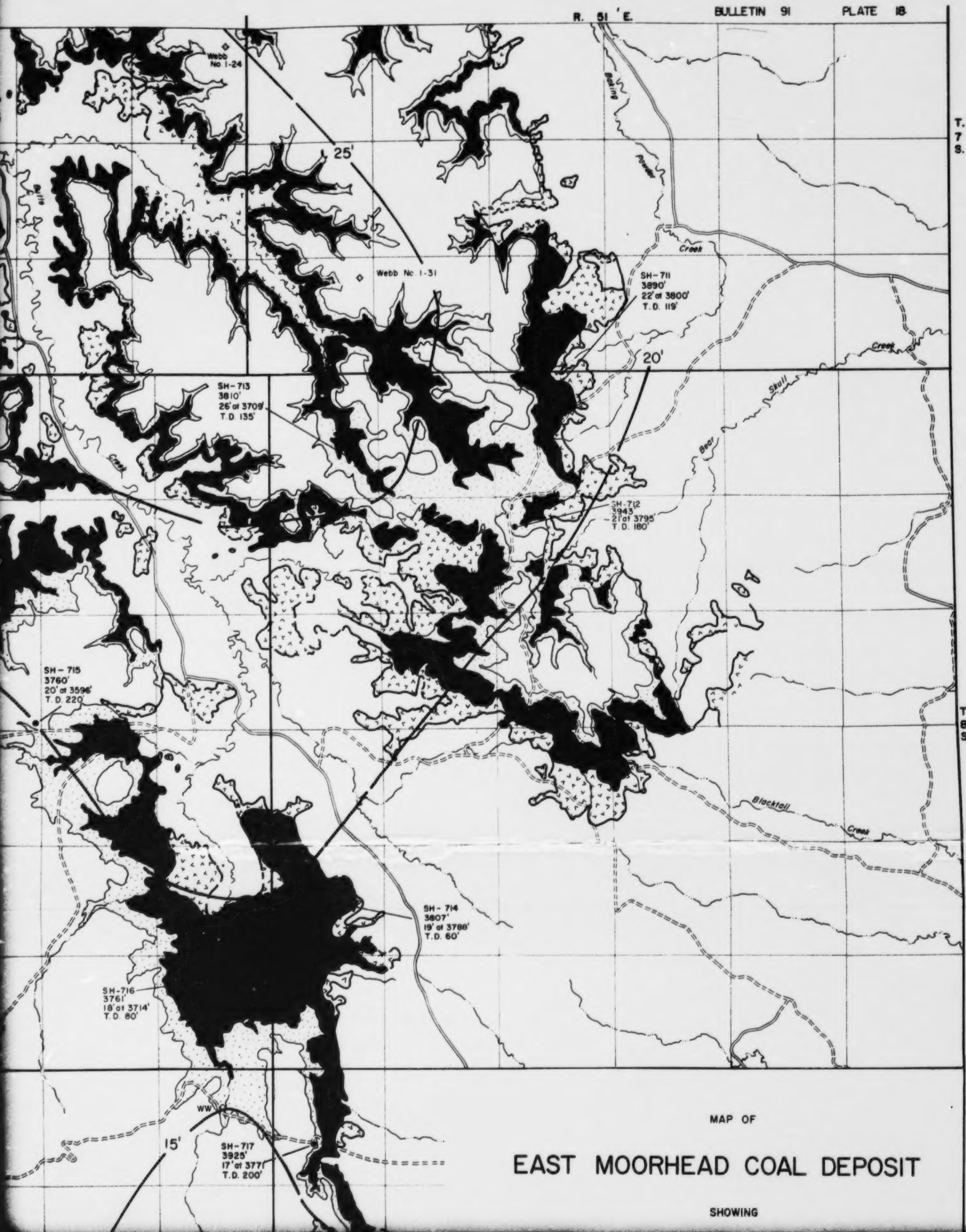
D

A

MONTANA BUREAU OF MINES AND GEOLOGY


R. 50 E.
T. 7 S.
T. 8 S.
Webb No. 1-24
Webb No. 1-33
Webb No. 1-31
WW
25'
25'
20'
15'
15'
Creek
Creek
Chandler No. 1
SH-713
3810'
26' at 3709'
T.D. 135'
SH-715
3760'
20' at 3596'
T.D. 220'
SH-714
3807'
19' at 3788'
T.D. 60'
SH-716
3761'
18' at 3714'
T.D. 60'
WW
SH-717
3925'
17' at 3771'
T.D. 200'
Pure Oil Co. No. 1

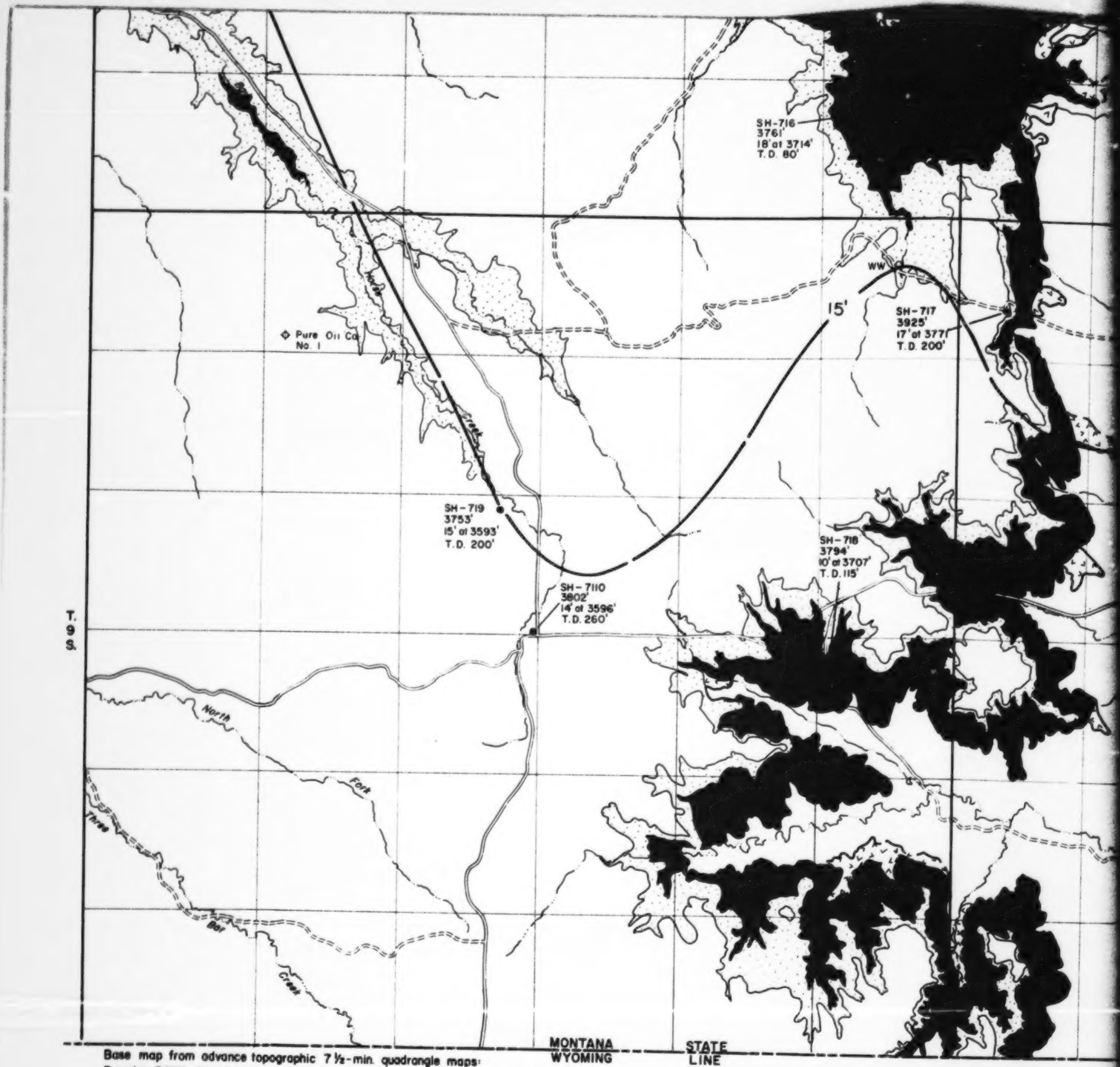
B


R. 51 E.
T. 7 S.
T. 8 S.
Webb No 1-24
Webb No. 1-31
25'
20'
15'
SH-711
3890'
22' at 3800'
T.D. 119'
SH-713
3810'
26' at 3709'
T.D. 135'
SH-712
3943'
21' at 3795'
T.D. 180'
SH-715
3760'
20' at 3596'
T.D. 220'
SH-714
3807'
19' at 3788'
T.D. 60'
SH-716
3761'
18' at 3714'
T.D. 80'
SH-717
3925'
17' at 3771
T.D. 200'
WW
Creek
Creek
Bear
Skull
Creek
Blacktail
Creek
Powder

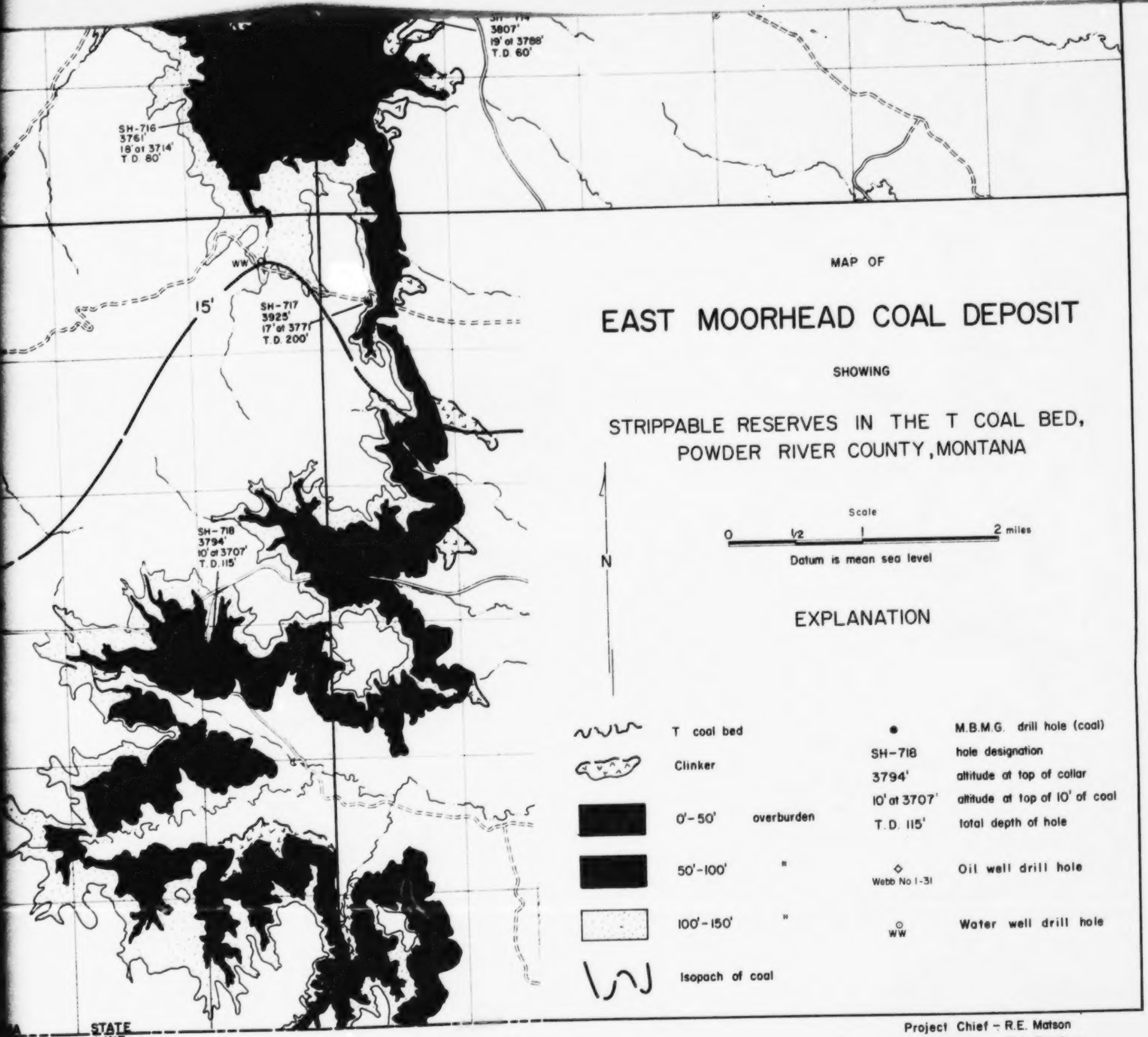
MAP OF

EAST MOORHEAD COAL DEPOSIT

SHOWING


SH-716
3761'
18' at 3714'
T.D. 80'
WW
15'
SH-717
3925'
17' at 3771
T.D. 200'
Pure Oil Co.
No. 1
Horse
Creek
SH-719
3753'
15' at 3593'
T.D. 200'
SH-718
3794'
10' at 3707'
T.D. 115'
SH-7110
3802'
14' at 3596'
T.D. 260'
T.
9
S.
North
Fork
Three
Bar
Creek
MONTANA
WYOMING
STATE
LINE

Base map from advance topographic 7½-min. quadrangle maps:
Broadus 3NW, Broadus 3SW, Selway 4SE, Selway 4SW,
Kruger, Pinto.


SH-714
3807'
19' at 3788'
T.D. 60'
SH-716
3761'
18' at 3714'
T.D. 80'
WW
15'
SH-717
3925'
17' at 3771'
T.D. 200'
SH-718
3794'
10' at 3707'
T.D. 115'
N
STATE LINE

MAP OF

EAST MOORHEAD COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE T COAL BED, POWDER RIVER COUNTY, MONTANA

Scale
0 1/2 1 2 miles
Datum is mean sea level

EXPLANATION

T coal bed

Clinker

■ 0'-50' overburden

■ 50'-100' "

░ 100'-150' "

Isopach of coal

● M.B.M.G. drill hole (coal)

SH-718 hole designation

3794' altitude at top of collar

10' at 3707' altitude at top of 10' of coal

T.D. 115' total depth of hole

◇ Webb No 1-31 Oil well drill hole

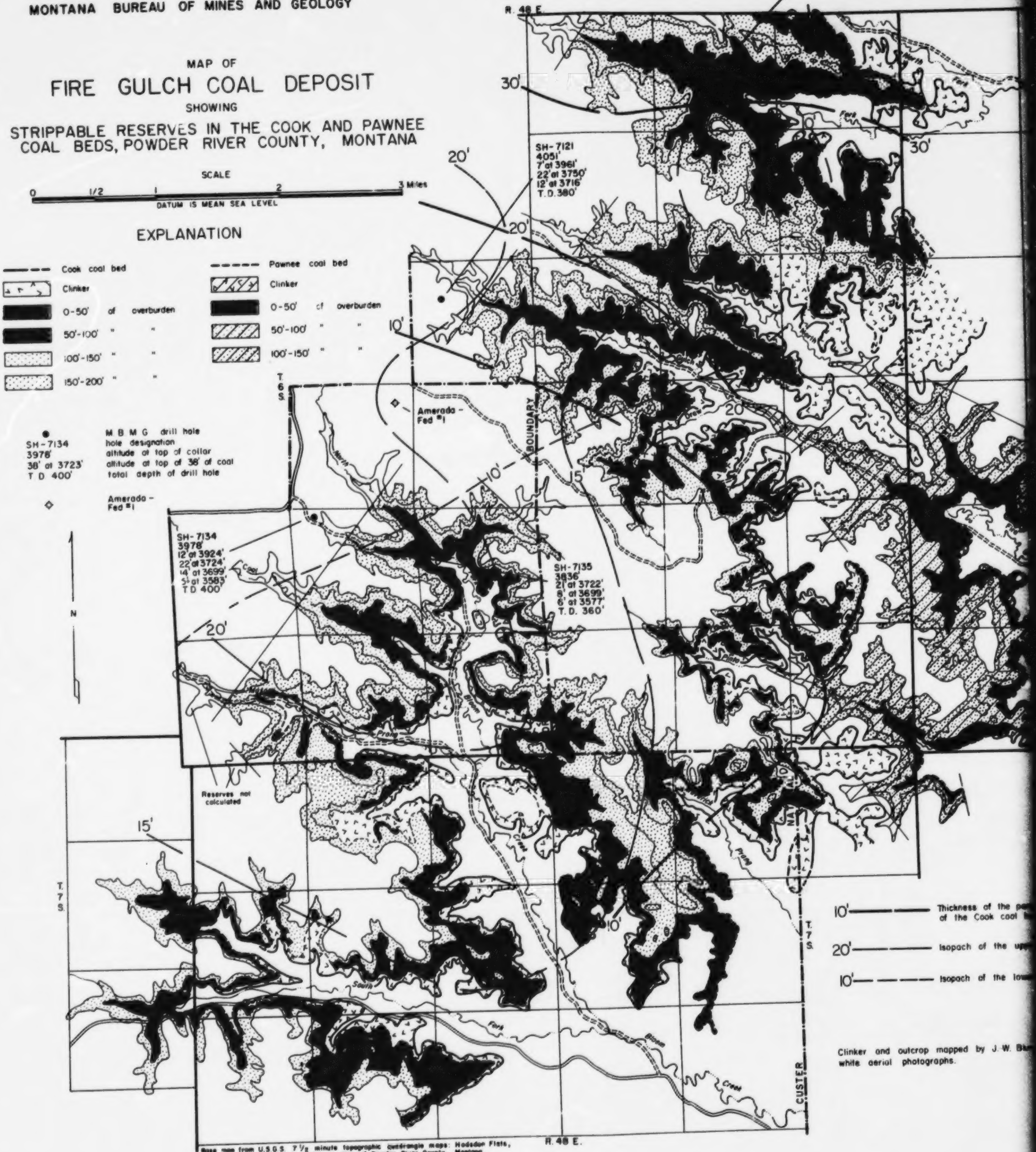
◎ WW Water well drill hole

Project Chief – R.E. Matson
Geologist – M.L. Granberg
Draftsman – M.J. Daniels

D

A

MAP OF
FIRE GULCH COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE COOK AND PAWNEE COAL BEDS, POWDER RIVER COUNTY, MONTANA


SCALE
0
1/2
1
2
3 Miles
DATUM IS MEAN SEA LEVEL
EXPLANATION
Cook coal bed
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
Pawnee coal bed
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
●
SH-7134
3978'
38' at 3723'
T D 400'
M B M G drill hole
hole designation
altitude at top of collar
altitude at top of 38' of coal
total depth of drill hole
◇
Amerada - Fed #1
N
R. 48 E.
T. 6 S.
T. 7 S.
30'
20'
10'
15'
SH-7121
4051'
7' at 3961'
22' at 3750'
12' at 3716'
T.D. 380'
Amerada - Fed #1
BOUNDARY
SH-7134
3978'
12' at 3924'
22' at 3724'
14' at 3699'
5' at 3583'
T D 400'
SH-7135
3836'
21' at 3722'
8' at 3699'
6' at 3577'
T.D. 360'
Reserves not calculated
North
Fork
Coal
Prong
Bloom
Creek
South
CUSTER
10' Thickness of the pa
of the Cook coal b
20' Isopach of the upp
10' Isopach of the low
Clinker and outcrop mapped by J. W. Bl
white aerial photographs.

Base map from U.S.G.S. 7½ minute topographic quadrangle maps: Hodsdon Flats, Phillips Butte, and General Highway Map of Powder River County, Montana.

MAP OF

CH COAL DEPOSIT

SHOWING

VES IN THE COOK AND PAWNEE
ER RIVER COUNTY, MONTANA

SCALE

2 3 Miles

IS MEAN SEA LEVEL

ANATION

- - - - - Pawnee coal bed

▨ Clinker

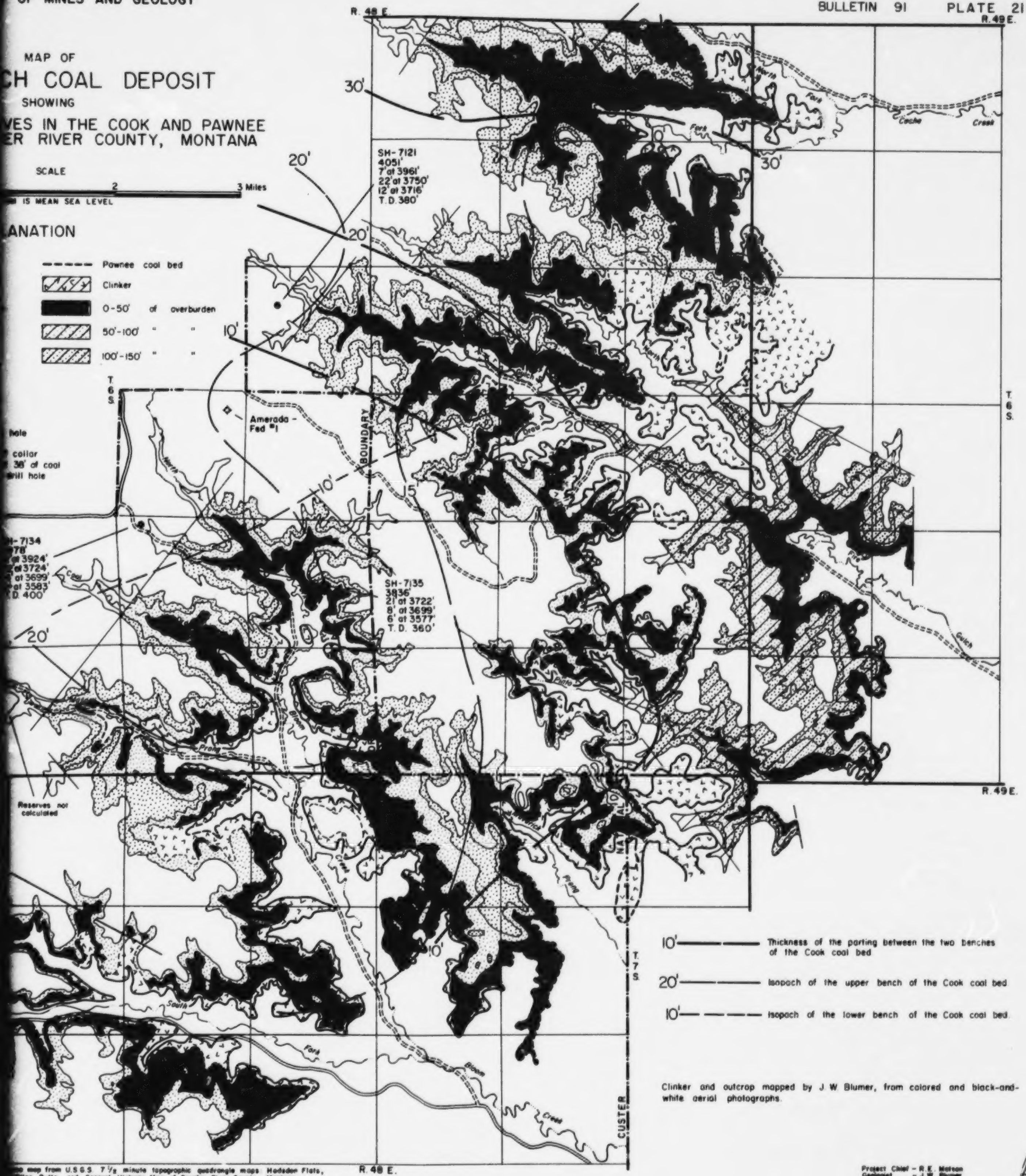
■ 0-50' of overburden

▨ 50'-100' " "

▨ 100'-150' " "

hole

collar
38' of coal
drill hole


R. 48 E.
R. 49 E.
T. 6 S.
T. 7 S.
30'
20'
10'
15
20
SH-7121
4051'
7' at 3961'
22' at 3750'
12' at 3716'
T.D. 380'
Amerada - Fed #1
BOUNDARY
H-7134
978'
at 3924'
at 3724'
at 3699'
at 3583'
T.D. 400'
SH-7135
3836'
21' at 3722'
8' at 3699'
6' at 3577'
T.D. 360'
North Fork Cache Creek
Fork
Gulch
Pinto
Coal
Prong
Bloom Creek
South Fork Bloom Creek
North
Reserves not calculated
CUSTER

10' ——— Thickness of the parting between the two benches of the Cook coal bed

20' ——— Isopach of the upper bench of the Cook coal bed

10' — — — Isopach of the lower bench of the Cook coal bed

Clinker and outcrop mapped by J. W. Blumer, from colored and black-and-white aerial photographs.

map from U.S.G.S. 7 1/2 minute topographic quadrangle maps: Hodsdon Flats, Phillips Butte, and General Highway Map of Powder River County, Montana.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - M. J. Daniels

B

A

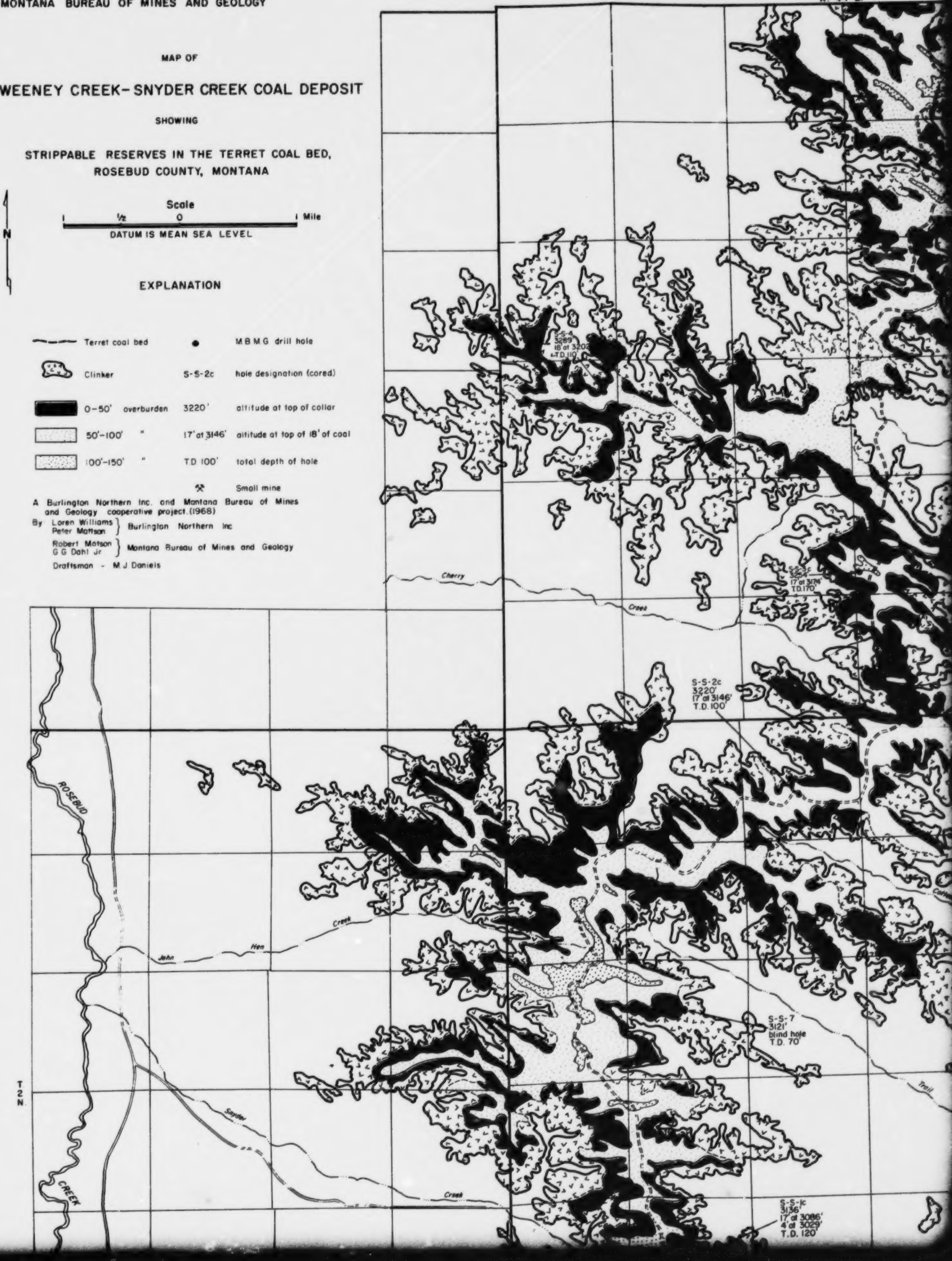
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

SWEENEY CREEK-SNYDER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE TERRET COAL BED, ROSEBUD COUNTY, MONTANA


Scale
1 ½ 0 1 Mile
DATUM IS MEAN SEA LEVEL
N
R. 44 E.
T. 2 N.
Cherry Creek
John Hen Creek
Snyder Creek
ROSEBUD CREEK
Trail
Cotton
S-S-4 3289 18 at 3202 T.D. 110'
S-S-3c 3254 17 at 3174' T.D. 170'
S-S-2c 3220' 17' at 3146' T.D. 100'
S-S-7 3121 blind hole T.D. 70'
S-S-1c 3136' 17' at 3086' 4' at 3029' T.D. 120'

EXPLANATION

~ Terret coal bed		●	M B M G drill hole
Clinker		S-S-2c	hole designation (cored)
■ 0-50'	overburden	3220'	altitude at top of collar
▨ 50'-100'	"	17' at 3146'	altitude at top of 18' of coal
▨ 100'-150'	"	T.D 100'	total depth of hole
		⚒	Small mine

A Burlington Northern Inc. and Montana Bureau of Mines and Geology cooperative project. (1968)

By Loren Williams, Peter Mattson } Burlington Northern Inc

Robert Matson, G G Dahl Jr } Montana Bureau of Mines and Geology

Draftsman - M J Daniels

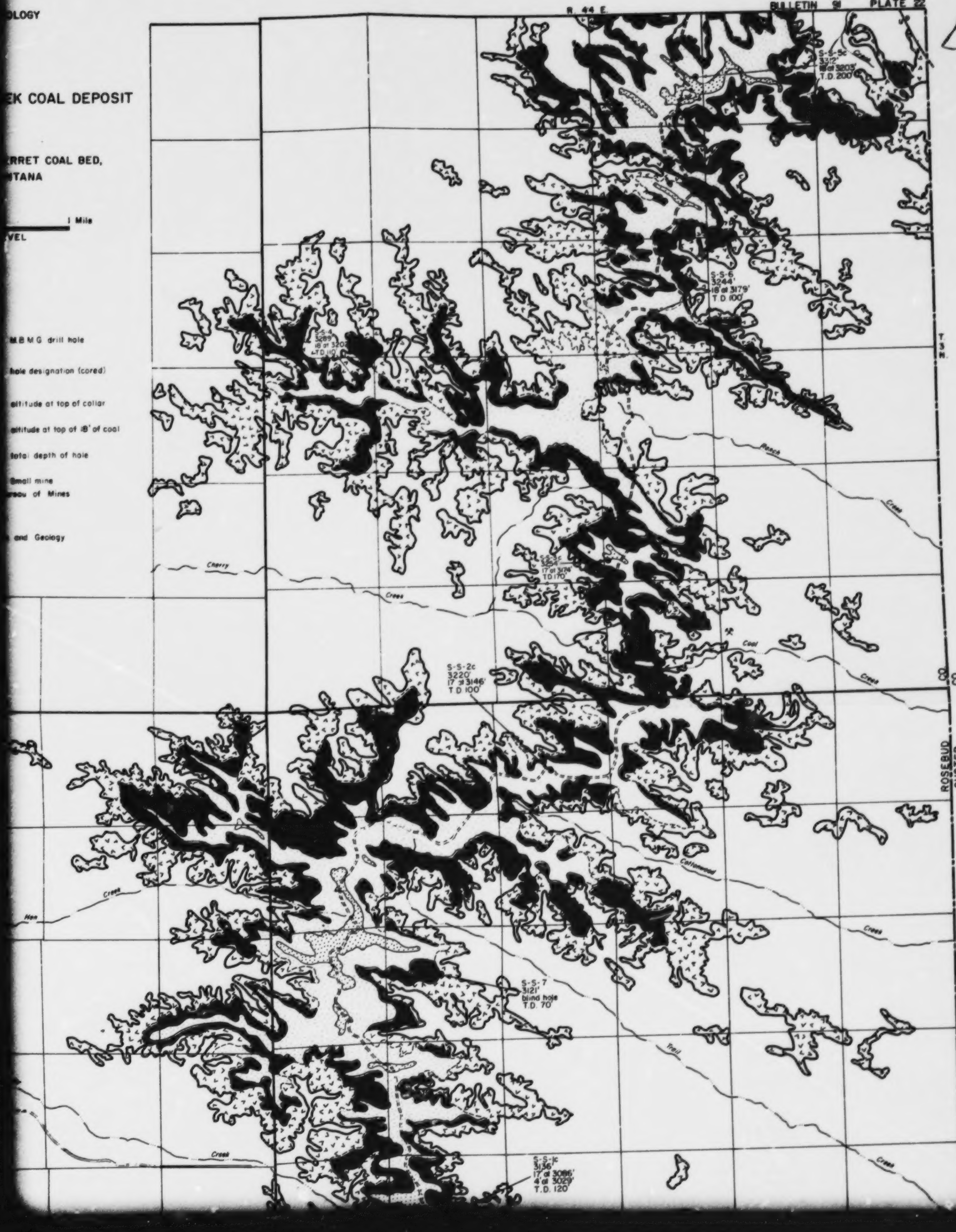
BULLETIN 91 PLATE 22

B

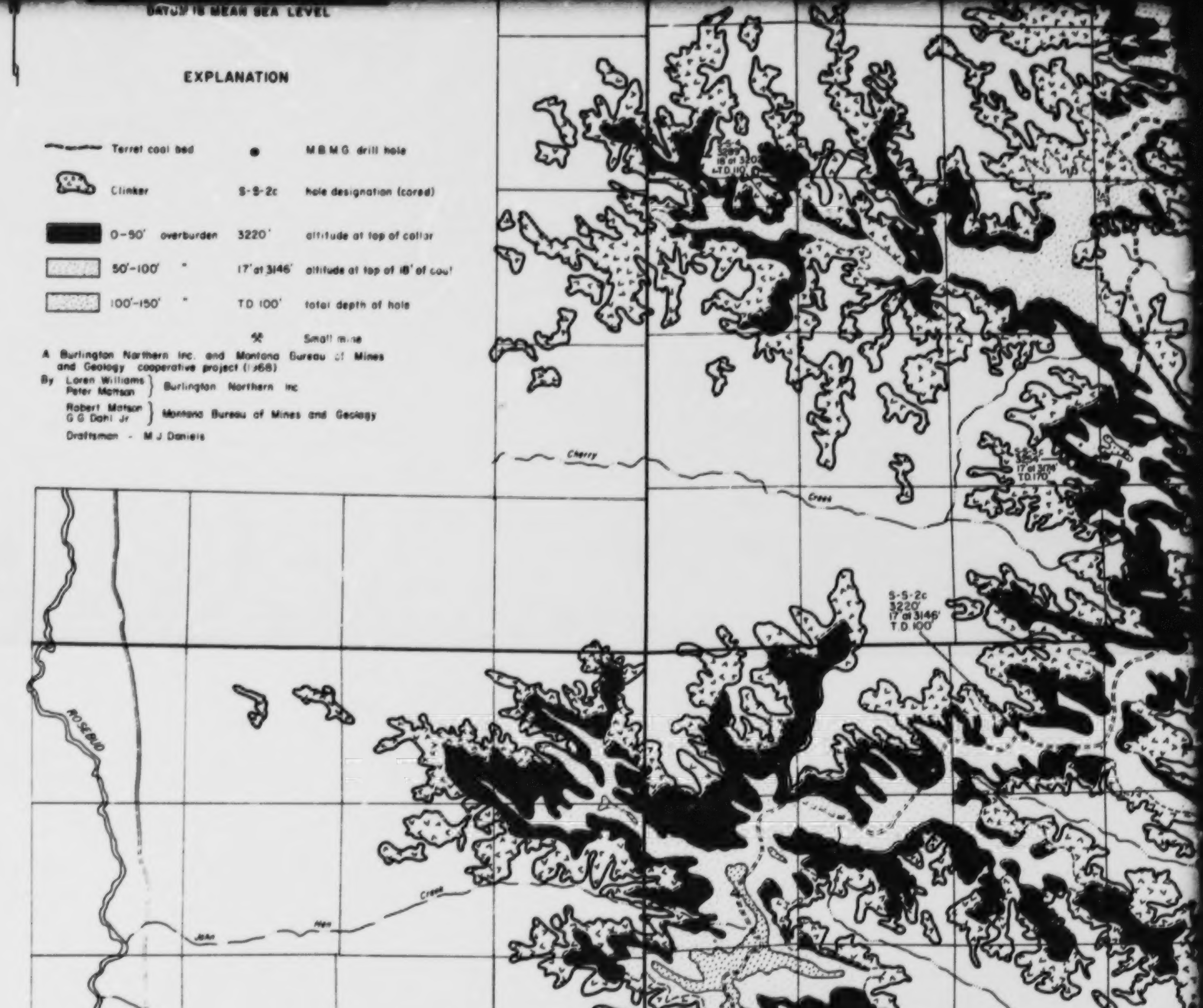
OLOGY

EK COAL DEPOSIT

RRET COAL BED,
NTANA


1 Mile
VEL
MBMG drill hole
hole designation (cored)
altitude at top of collar
altitude at top of 18' of coal
total depth of hole
Small mine
reau of Mines
and Geology
R. 44 E.
S-S-5c
3312'
18' at 3203'
T.D. 200'
Creek
S-S-6
3244'
18' at 3179'
T.D. 100'
T. 3 N.
S-S-4
3289'
18' at 3202'
T.D. 110'
Ranch
Creek
Cherry
Creek
S-S-3c
3254'
17' at 3174'
T.D. 170'
Coal
Creek
S-S-2c
3220'
17' at 3146'
T.D. 100'
ROSEBUD
CUSTER
Cottonwood
Creek
Hay
Creek
S-S-7
3121'
blind hole
T.D. 70'
Trail
Creek
T. 2 N.
Creek
S-S-1c
3136'
17' at 3086'
4' at 3029'
T.D. 120'

DATUM IS MEAN SEA LEVEL



EXPLANATION
Terret coal bed
Clinker
0-50' overburden
50'-100' "
100'-150' "
● MBMG drill hole
S-S-2c hole designation (cored)
3220' altitude at top of collar
17' at 3146' altitude at top of 18' of coal
T.D. 100' total depth of hole
Small mine
S-S-4
18' at 3202
T.D. 110
3254
17' at 3176'
T.D. 170'
Cherry
Creek
S-S-2c
3220'
17' at 3146'
T.D. 100'
ROSEBUD
John
Hen
Creek
S-S-7
3121'
blind hole
T.D. 70'
T 2 N
Snyder
Creek
Trail
CREEK
S-S-1c
3136
17' at 3086'
4' at 3029'
T.D. 120'
S-S-8
3194'
13' at 3109'
T.D. 110
R. 43 E.
R. 44 E.

A Burlington Northern Inc. and Montana Bureau of Mines and Geology cooperative project (1968)

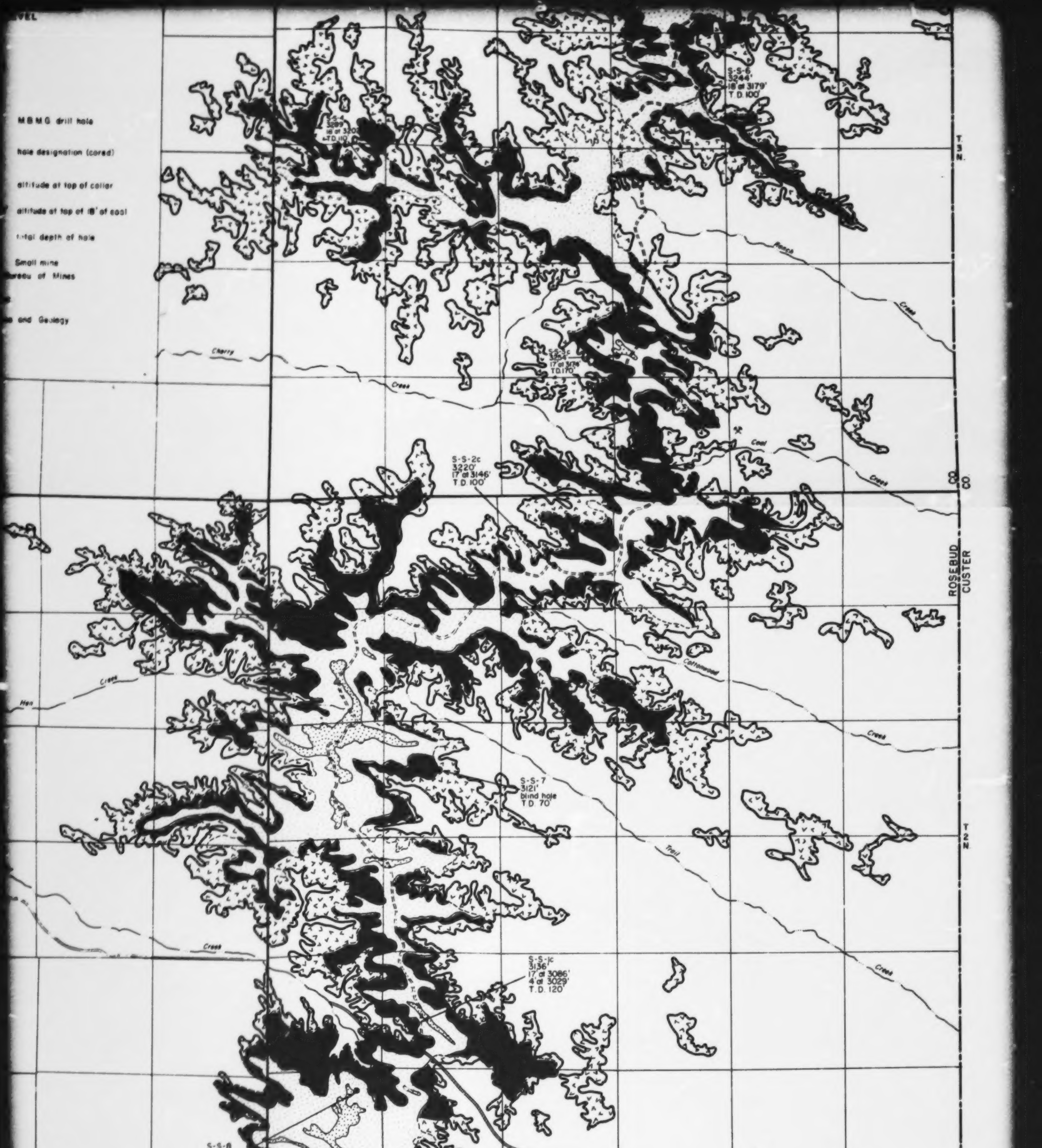
By Loren Williams, Peter Mattson } Burlington Northern Inc

Robert Matson, G.G. Dahl Jr } Montana Bureau of Mines and Geology

Draftsman - M.J. Daniels

Base map from General Highway Map Rosebud County, Sheet 7

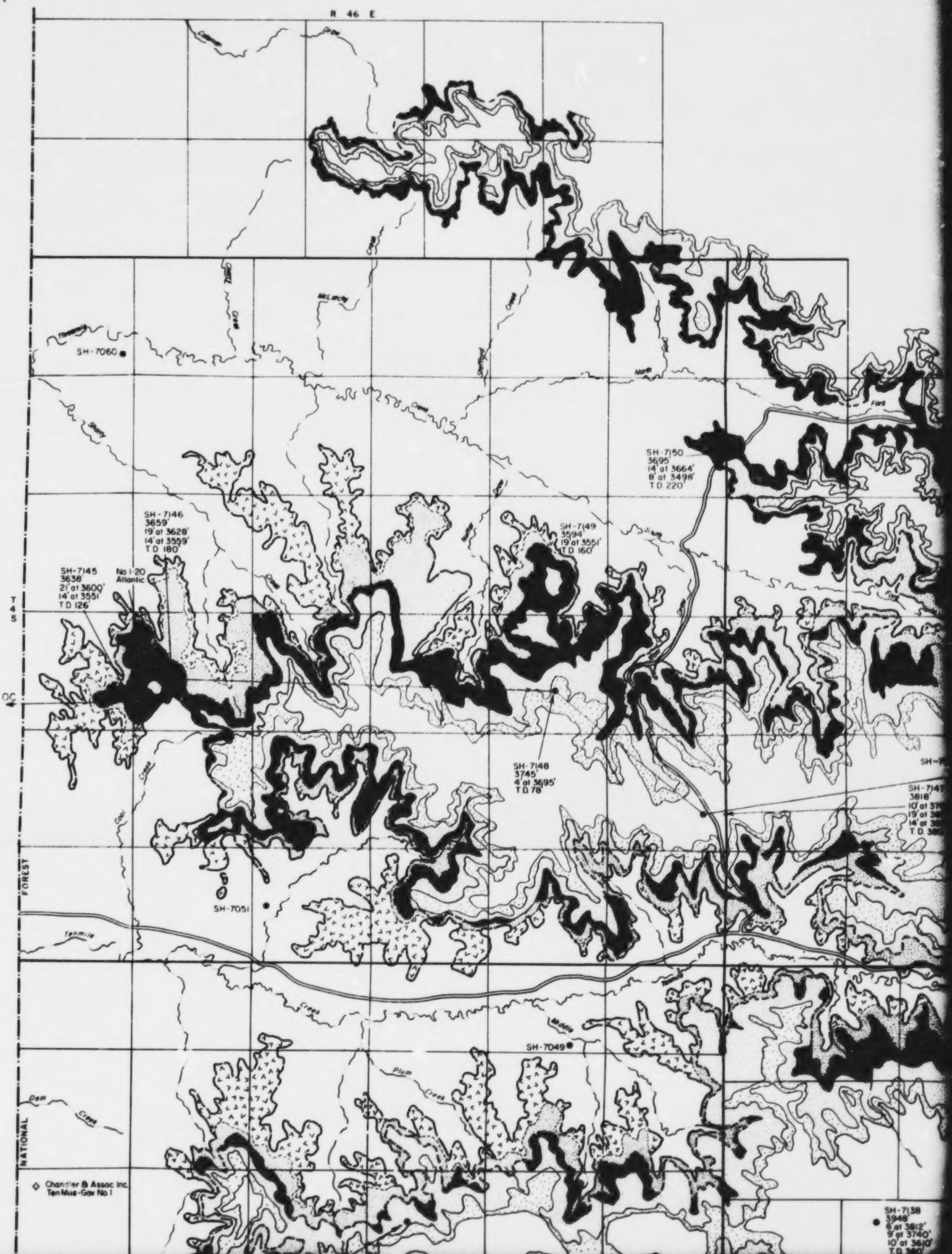
C


VEL
MBMG drill hole
hole designation (cored)
altitude at top of collar
altitude at top of 18' of coal
total depth of hole
Small mine
Bureau of Mines
and Geology
S-S-4
3289'
18' at 3202'
T.D. 110'
S-S-6
3244'
18' at 3179'
T.D. 100'
S-S-3c
3254'
17' at 3174'
T.D. 170'
S-S-2c
3220'
17' at 3146'
T.D. 100'
S-S-7
3121'
blind hole
T.D. 70'
S-S-1c
3136'
17' at 3086'
4' at 3029'
T.D. 120'
S-S-8
3194'
13' at 3109'
T.D. 110'
Ranch
Creek
Cherry
Creek
Coal
Creek
Cottonwood
Creek
Hay
Creek
Trail
Creek
Creek
T. 3 N.
T. 2 N.
ROSEBUD
CUSTER
R. 43 E.
R. 44 E.

D

A

MONTANA BUREAU OF MINES AND GEOLOGY


R 46 E
SH-7060
McCarty
Creek
North
Fork
Sheep
SH-7150
3695'
14' at 3664'
8' at 3498'
T D 220'
SH-7146
3659'
19' at 3628'
14' at 3559'
T D 180'
SH-7149
3594'
19' at 3551'
T D 160'
SH-7145
3638'
21' at 3600'
14' at 3551'
T D 126'
No 1-20
Atlantic
T 4 S
SH-7148
3745'
4' at 3695'
T D 78'
SH-7147
3818'
10' at
19' at
14' at
T D
SH-
SH-7051
FOREST
Tenmile
Creek
Middle
SH-7049
Plum Creek
Dam Creek
NATIONAL
Chandler & Assoc Inc.
Ten Mile-Gov No 1
SH-7138
3948'
6' at 3812'
9' at 3740'
10' at 3610'
T.D 360'

B

Map of

YAGER BUTTE COAL DEPOSIT

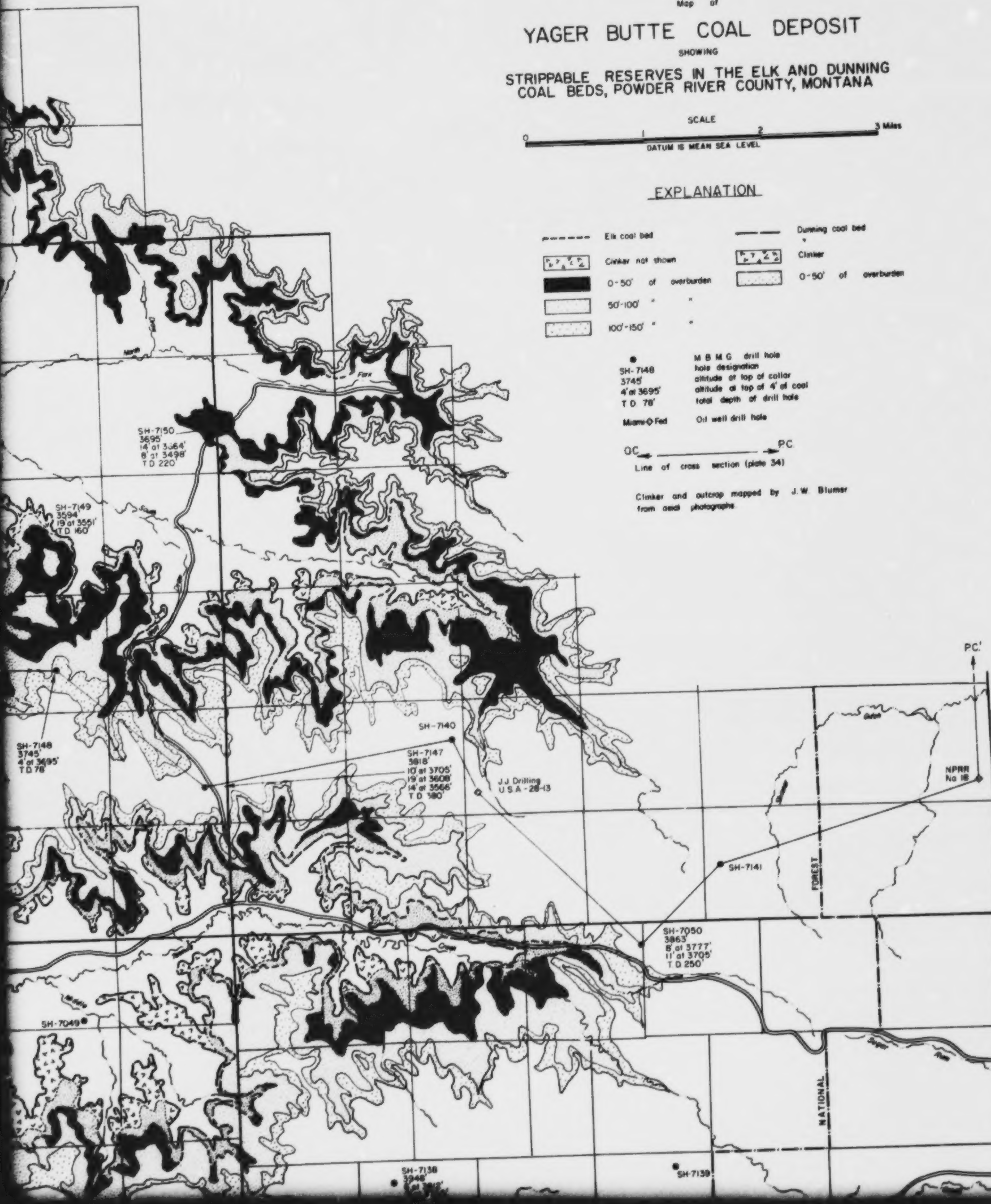
SHOWING

STRIPPABLE RESERVES IN THE ELK AND DUNNING COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1 2 3 Miles

DATUM IS MEAN SEA LEVEL


SH-7150
3695'
14' at 3564'
8' at 3498'
T D 220'
SH-7149
3594
19' at 3551'
T D 160'
SH-7148
3745'
4' at 3695'
T D 78'
SH-7140
SH-7147
3818'
10' at 3705'
19' at 3608'
14' at 3566'
T D 180'
J.J. Drilling
U.S.A.-28-13
NPRR
No 18
PC'
SH-7141
SH-7050
3863'
8' at 3777'
11' at 3705'
T D 250'
SH-7049
SH-7138
3948'
SH-7139
North
Fork
South
FOREST
NATIONAL
N

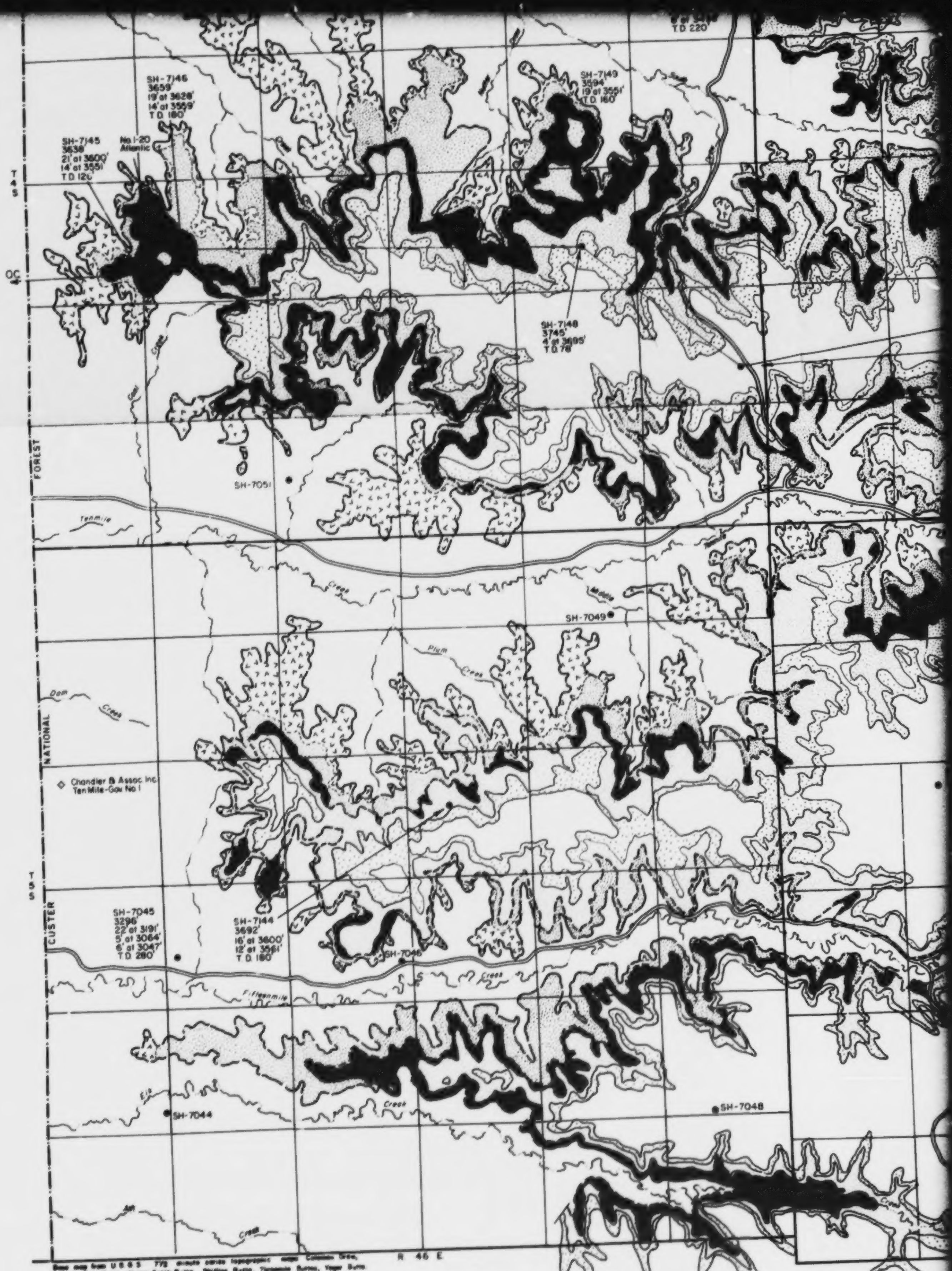
EXPLANATION

- - - - - -	Elk coal bed	— —	Dunning coal bed
▨	Clinker not shown	▨	Clinker
■	0-50' of overburden	▨	0-50' of overburden
▨	50'-100' " "		
▨	100'-150' " "		

●	M B M G drill hole
SH-7148	hole designation
3745'	altitude at top of collar
4' at 3695'	altitude at top of 4' of coal
T D 78'	total depth of drill hole
Miami ◇ Fed	Oil well drill hole

QC ← → PC
Line of cross section (plate 34)

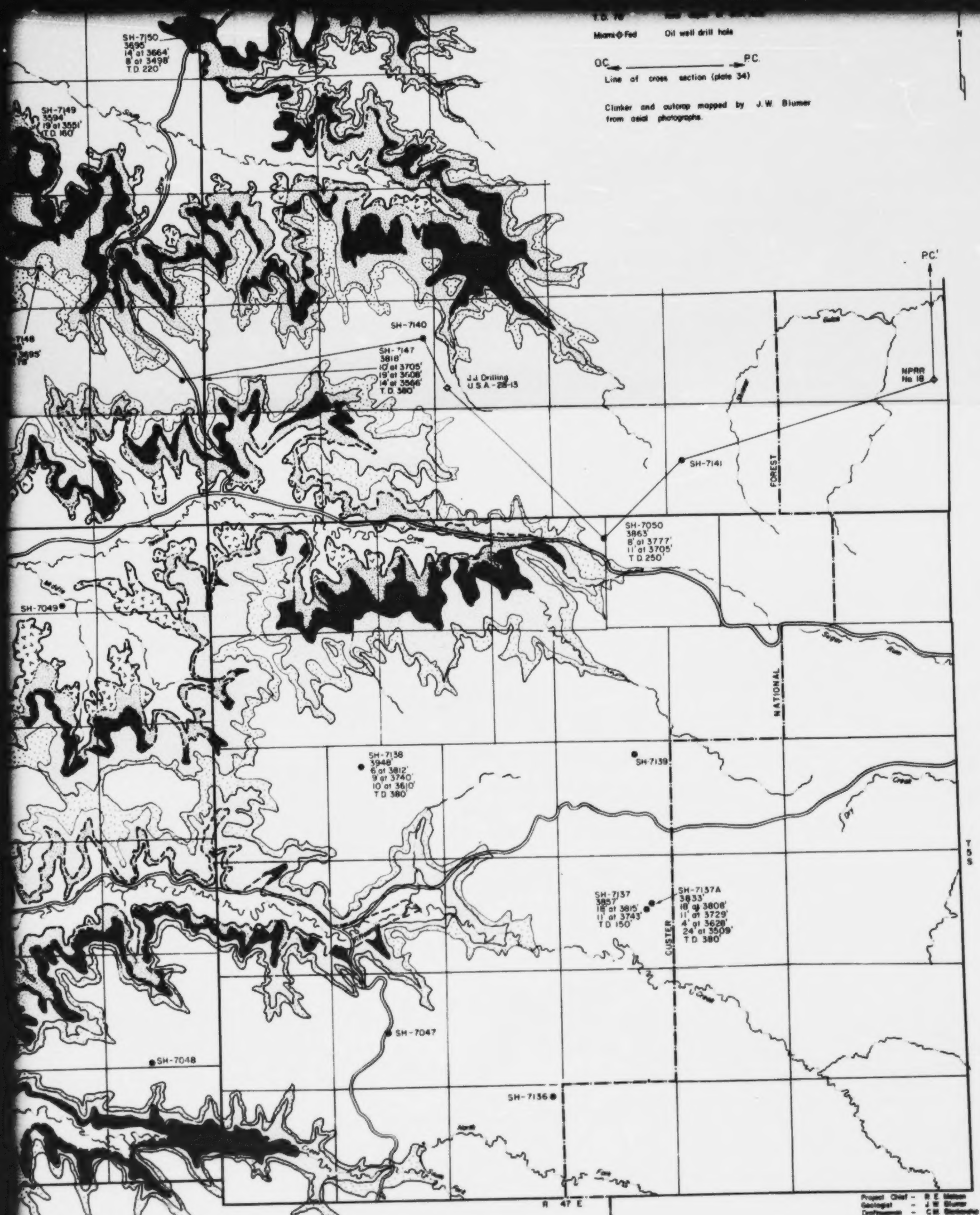
Clinker and outcrop mapped by J.W. Blumer from aerial photographs



T 4 S
OC
SH-7145
3638'
21' at 3600'
14' at 3551'
T.D. 120'
No. 1-20
Atlantic
SH-7146
3659'
19' at 3628'
14' at 3559'
T.D. 180'
SH-7149
3594'
19' at 3551'
T.D. 160'
T.D. 220'
SH-7148
3745'
4' at 3695'
T.D. 78'
Creek
FOREST
SH-7051
Tenmile
Creek
Middle
SH-7049
Plum
Creek
Dam
Creek
NATIONAL
Chandler & Assoc. Inc.
Ten Mile-Gov. No. 1
T 5 S
CUSTER
SH-7045
3296'
22' at 3191'
5' at 3064'
6' at 3047'
T.D. 280'
SH-7144
3692'
16' at 3600'
12' at 3561'
T.D. 180'
SH-7046
Creek
Fifteenmile
Elk
Creek
SH-7044
SH-7048
Ash
Creek
R 46 E

Base map from U.S.G.S. 7½ minute series topographic maps: Coleman Draw, Goodspeed Butte, Home Creek Butte, Phillips Butte, Threemile Butte, Yager Butte

C


SH-7150
3695'
14' at 3664'
8' at 3498'
T.D. 220'
SH-7149
3594'
19' at 3551'
T.D. 160'
3695'
SH-7140
SH-7147
3818'
10' at 3705'
19' at 3608'
14' at 3566'
T.D. 380'
J.J. Drilling
U.S.A.-28-13
P.C.'
NPRR
No 18
SH-7141
FOREST
SH-7050
3863'
8' at 3777'
11' at 3705'
T.D. 250'
SH-7049
NATIONAL
Sugar
SH-7138
3948'
6' at 3812'
9' at 3740'
10' at 3610'
T.D. 380'
SH-7139
Creek
Dry
T 5 S
SH-7137
3857'
18' at 3815'
11' at 3743'
T.D. 150'
SH-7137A
3833'
18' at 3808'
11' at 3729'
4' at 3628'
24' at 3509'
T.D. 380'
CUSTER
Creek
SH-7047
SH-7048
SH-7136
Creek
R 47 E
N

T.D. 70

Miami ◇ Fed   Oil well drill hole

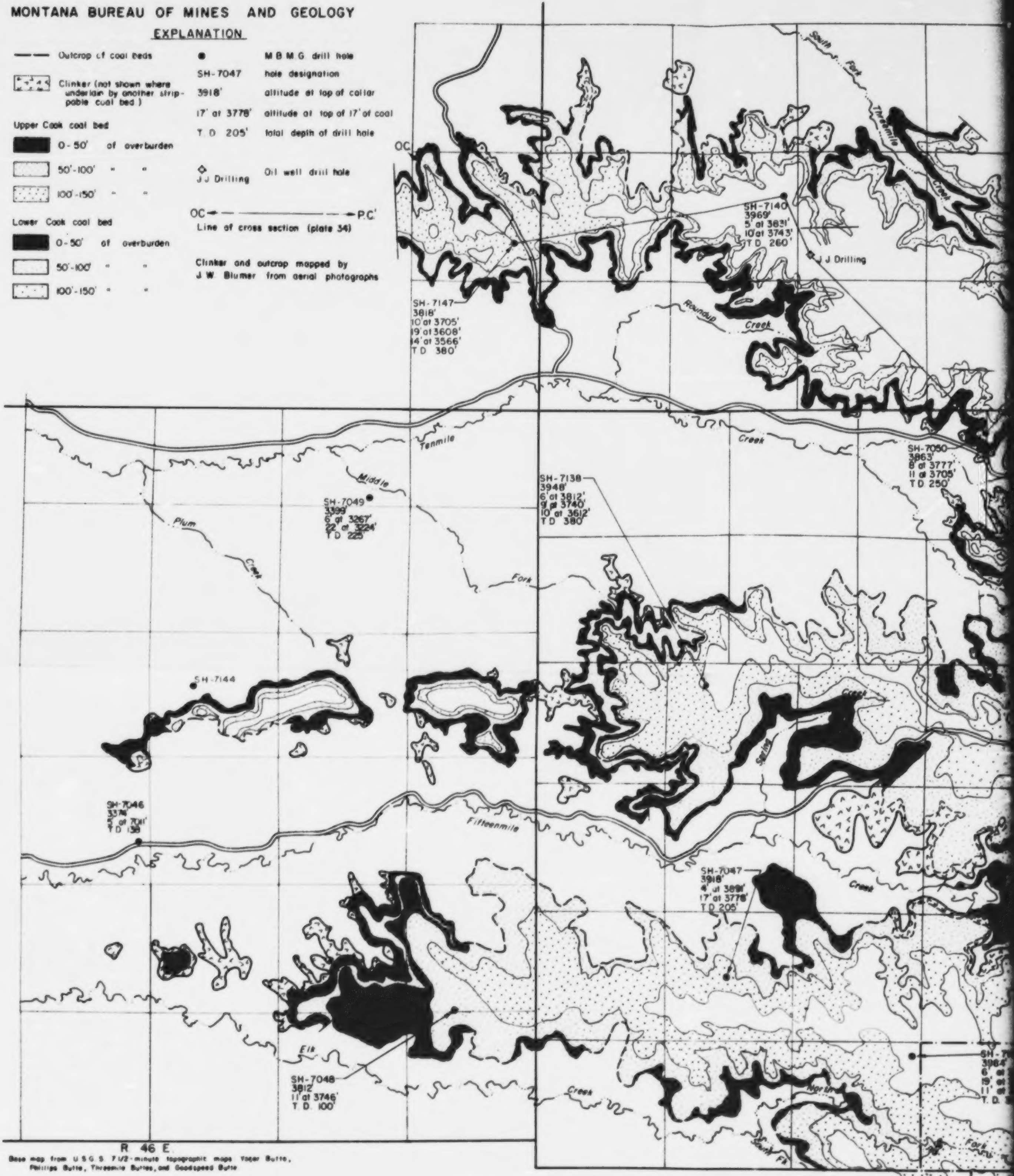
O.C. ← → P.C.
Line of cross section (plate 34)

Clinker and outcrop mapped by J.W. Blumer
from aerial photographs.

Project Chief - R.E. Matson
Geologist - J.W. Blumer
Draftsman - C.M. [illegible]

D

A


MONTANA BUREAU OF MINES AND GEOLOGY
EXPLANATION
Outcrop of coal beds
Clinker (not shown where underlain by another strippable coal bed)
Upper Cook coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
Lower Cook coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
M B M G drill hole
SH-7047 hole designation
3918' altitude at top of collar
17' at 3778' altitude at top of 17' of coal
T D 205' total depth of drill hole
J J Drilling Oil well drill hole
OC ← → P.C' Line of cross section (plate 34)
Clinker and outcrop mapped by J.W. Blumer from aerial photographs
OC
South Fork Threemile Creek
SH-7140 3969' 5' at 3831' 10' at 3743' T D 260'
J J Drilling
SH-7147 3818' 10' at 3705' 19' at 3608' 34' at 3566' T D 380'
Roundup Creek
Tenmile Creek
SH-7050 3863' 8' at 3777' 11' at 3705' T D 250'
SH-7138 3948' 6' at 3812' 9' at 3740' 10' at 3612' T D 380'
Middle Fork
Plum Creek
SH-7049 3399' 6' at 3267' 22' at 3224' T D 225'
SH-7144
Creek
Swing
SH-7046 3376' 5' at 7011' T D 138'
Fifteenmile Creek
SH-7047 3918' 4' at 3891' 17' at 3778' T D 205'
SH-7… 3964' 6' at 19' at 11' at T D
Elk Creek
SH-7048 3812 11' at 3746' T D 100'
North Fork
South Fk
Fork
R 46 E.
R. 47 E.
Base map from U.S.G.S. 7 1/2-minute topographic maps Yager Butte, Phillips Butte, Threemile Buttes, and Goodspeed Butte
N

MAP OF

YAGER BUTTE COAL DEPOSIT

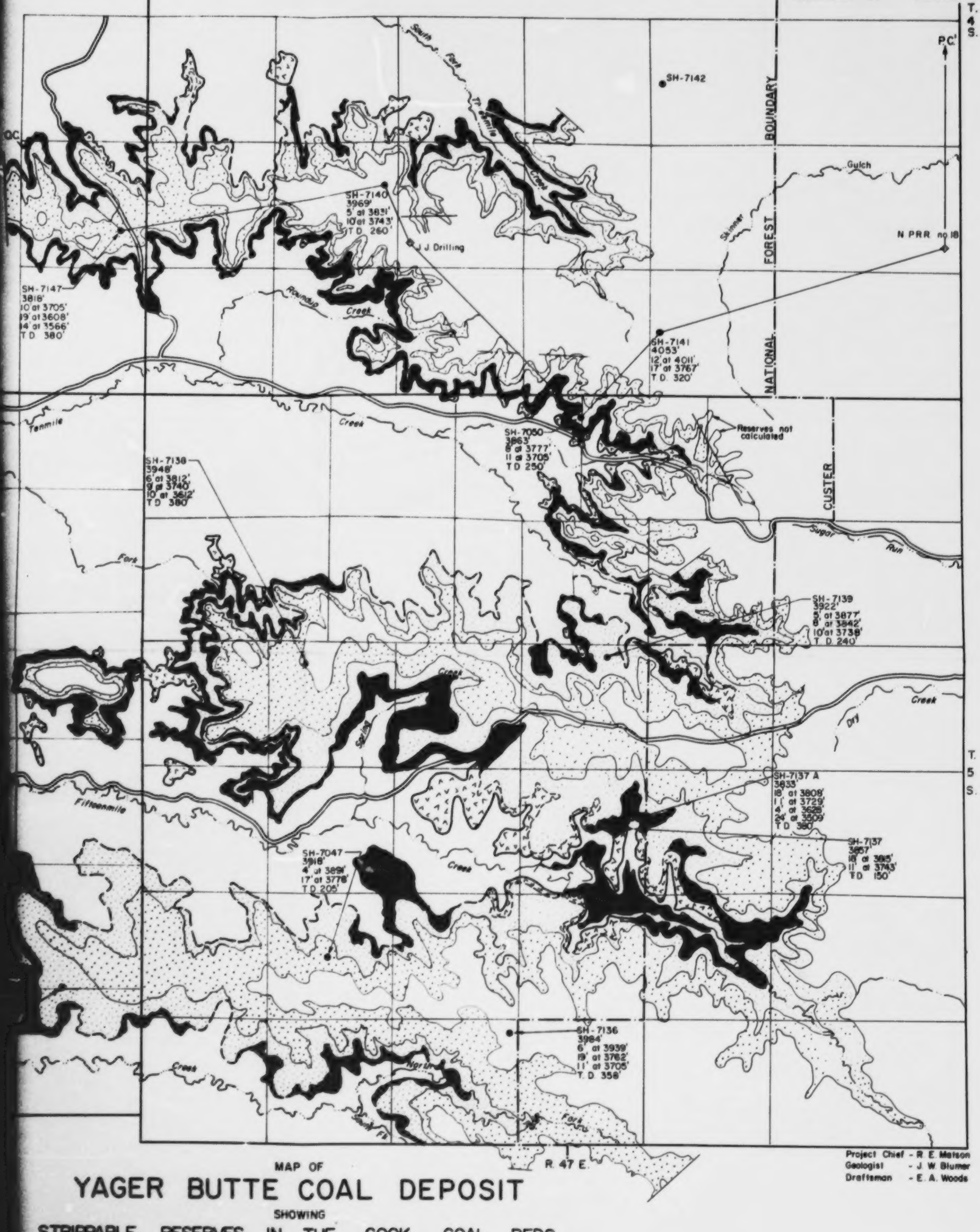
SHOWING

STRIPPABLE RESERVES IN THE COOK COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL


T.
4
S.
P.C'
SH-7142
BOUNDARY
FOREST
NATIONAL
CUSTER
Gulch
Skinner
N PRR no 18
South Fork
Tenmile
Creek
C
SH-7140
3969'
5' at 3831'
10' at 3743'
T D 260'
J J Drilling
SH-7147
3818'
10' at 3705'
19' at 3608'
14' at 3566'
T D 380'
Roundup
Creek
SH-7141
4053'
12' at 4011'
17' at 3767'
T D 320'
Tenmile
Creek
SH-7050
3863'
6' at 3777'
11' at 3705'
T D 250'
Reserves not calculated
SH-7138
3948'
6' at 3812'
9' at 3740'
10' at 3612'
T D 380'
Sugar
Run
Fork
SH-7139
3922'
5' at 3877'
8' at 3842'
10' at 3738'
T D 240'
Creek
Dry
Creek
T.
5
S.
SH-7137 A
3833'
18' at 3808'
11' at 3729'
4' at 3628'
24' at 3509'
T D 380'
Fifteenmile
SH-7137
3857'
18' at 3815'
11' at 3743'
T D 150'
SH-7047
3918'
4' at 3891'
17' at 3778'
T D 205'
Creek
SH-7136
3984'
6' at 3939'
19' at 3762'
11' at 3705'
T D 358'
Creek
North
South Fk
Fork
R. 47 E.

β

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

MAP OF

YAGER BUTTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE COOK COAL BEDS, POWDER RIVER COUNTY, MONTANA

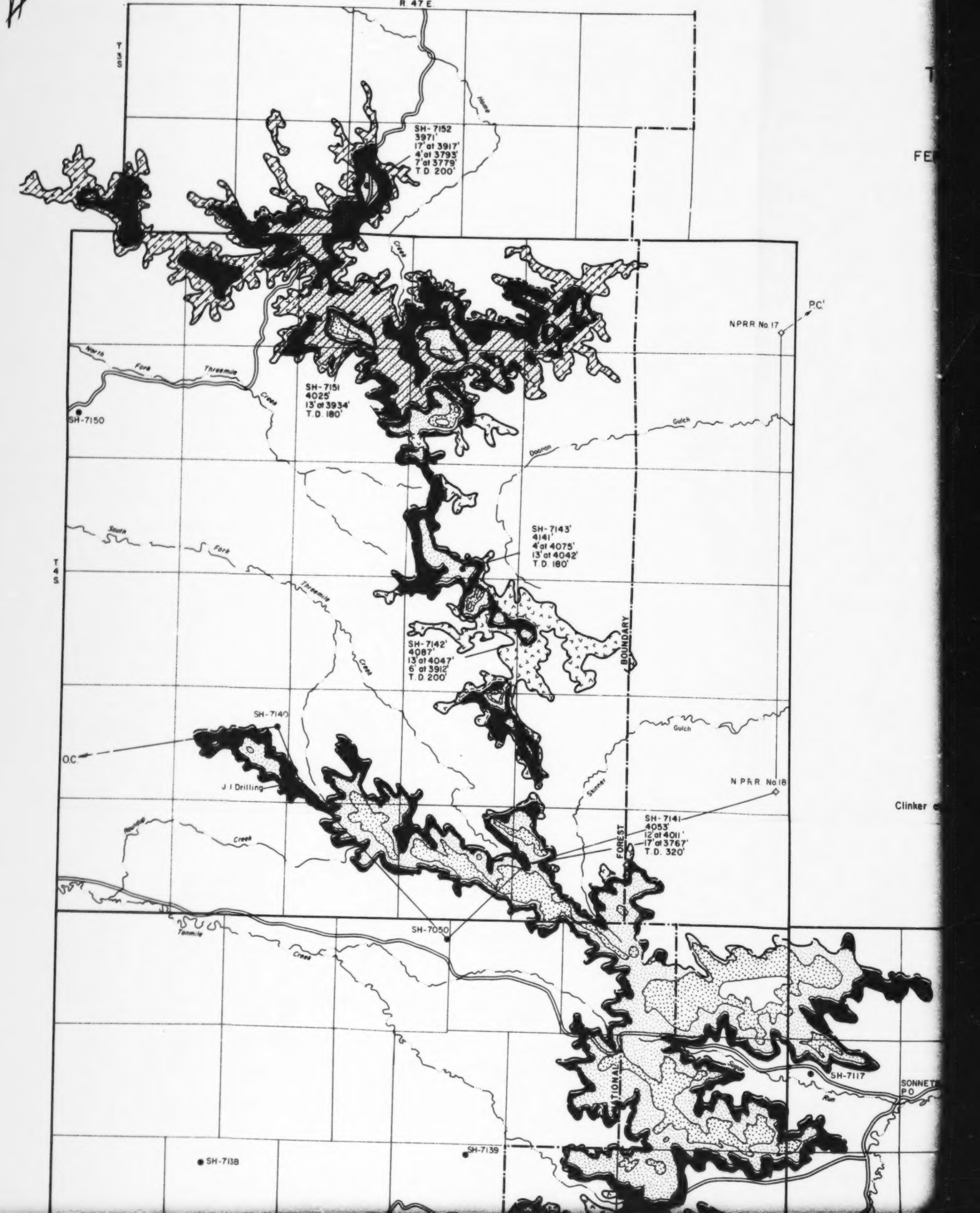
SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

A

MONTANA BUREAU OF MINES AND GEOLOGY


R. 47 E.
T 3 S
T 4 S
T
FE
Clinker a
SH-7152
3971'
17' at 3917'
4' at 3793'
7' at 3779'
T.D. 200'
Home
Creek
North Fork Threemile Creek
SH-7151
4025'
13' at 3934'
T.D. 180'
SH-7150
N.P.R.R. No. 17
P.C.'
Doonan Gulch
SH-7143'
4141'
4' at 4075'
13' at 4042'
T.D. 180'
South Fork Threemile Creek
SH-7142'
4087'
13' at 4047'
6' at 3912'
T.D. 200'
BOUNDARY
FOREST
TIONAL
SH-7140
O.C.
J. I. Drilling
Skinner Gulch
N.P.R.R. No. 18
SH-7141
4053'
12' at 4011'
17' at 3767'
T.D. 320'
Creek
SH-7050
Tenmile Creek
SH-7117
SONNETT
P.O.
Run
SH-7138
SH-7139

MAP OF

THREEMILE BUTTES COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE CANYON AND FERRY COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 Miles

DATUM IS MEAN SEA LEVEL

EXPLANATION

Clinker (not shown where underlain by another strippable coal bed)

CANYON COAL BED

■ 0-50' of overburden

☐ 50'-100' " "

░ 100'-150' " "

FERRY BED

■ 0-50' of overburden

▨ 50'-100' " "

◇ Oil well drill hole

● M.B.M.G. drill hole

SH-7143 hole designation

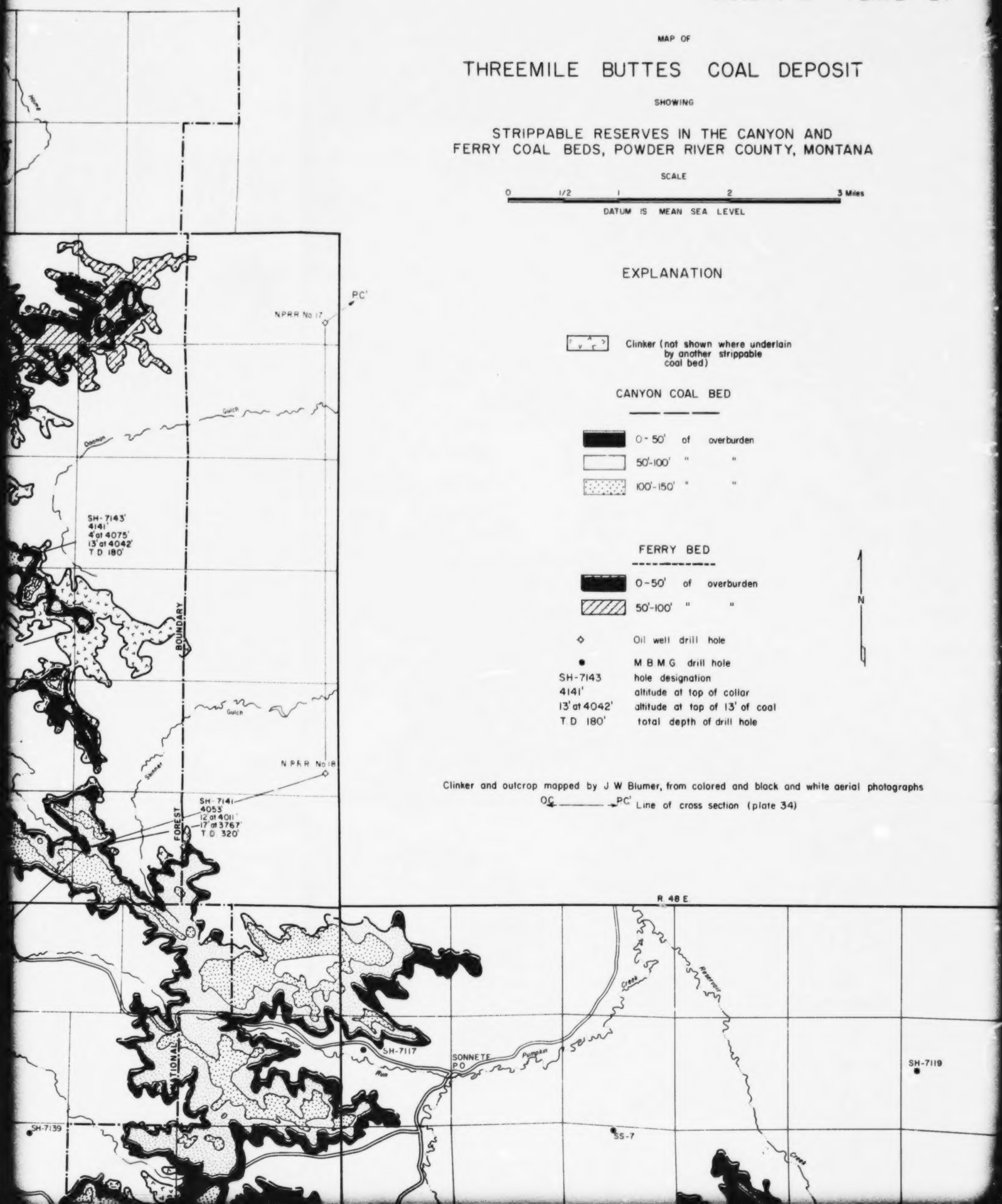
4141' altitude at top of collar

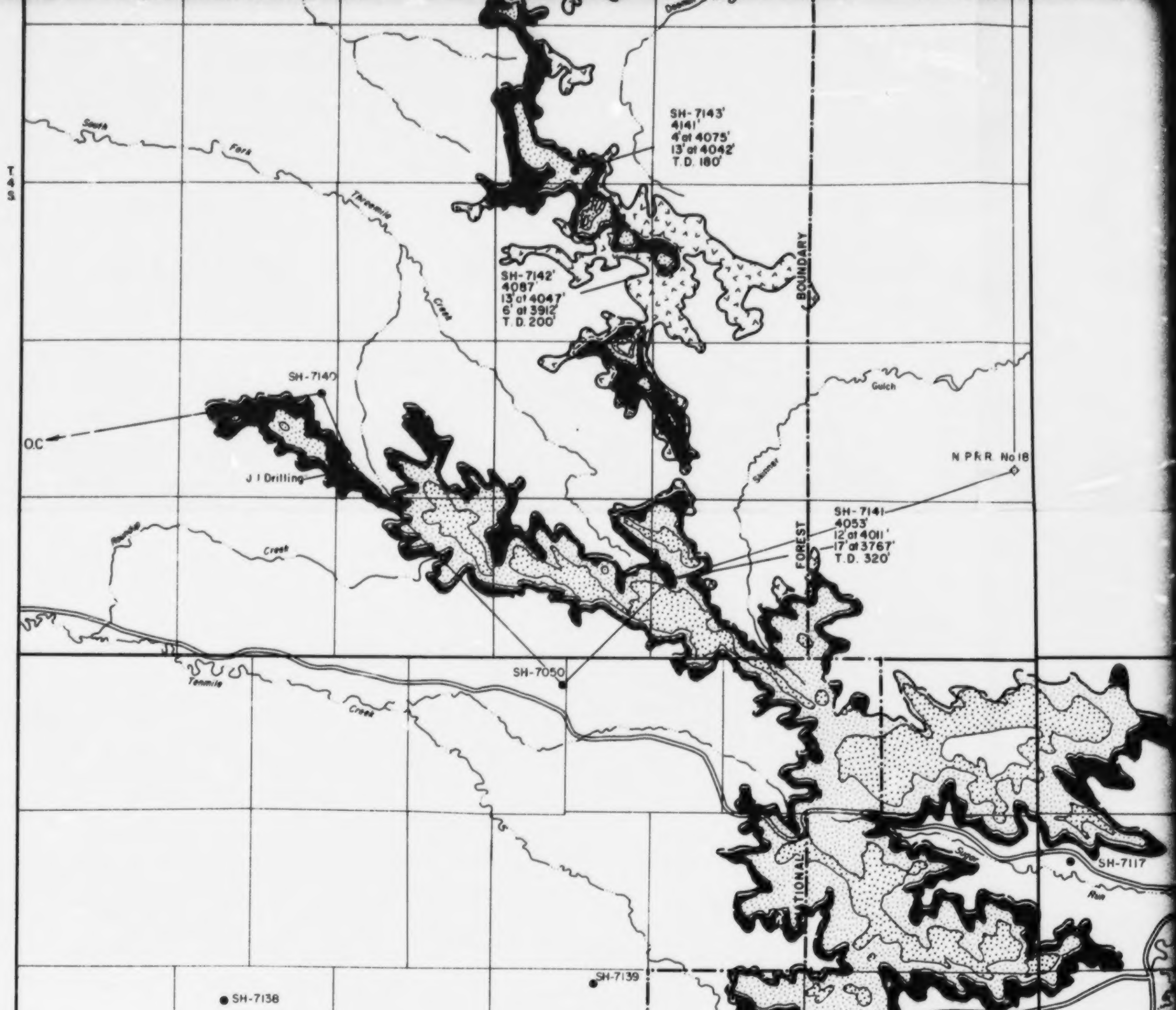
13' at 4042' altitude at top of 13' of coal

T.D. 180' total depth of drill hole

Clinker and outcrop mapped by J. W. Blumer, from colored and black and white aerial photographs

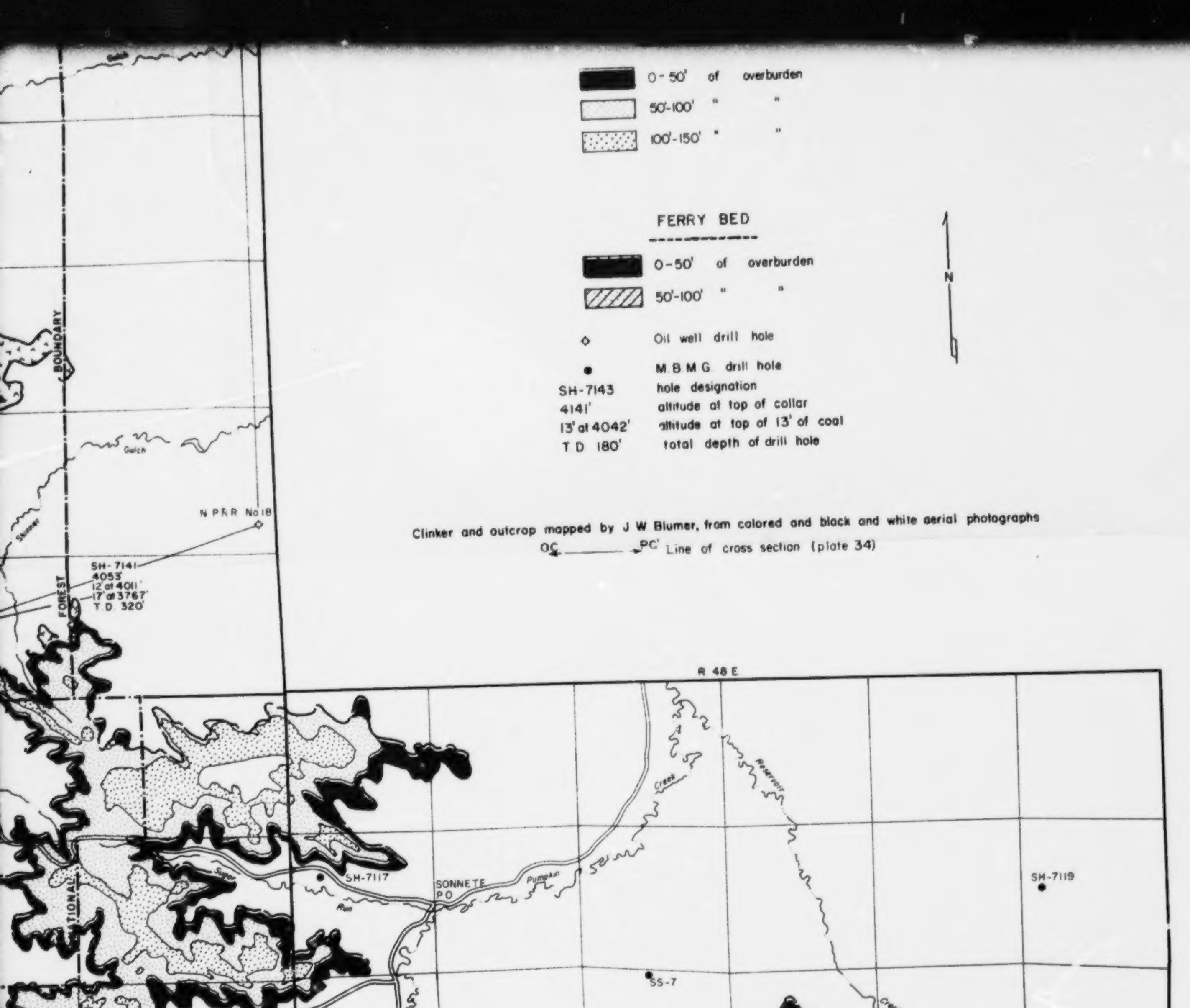
OC ←——→ PC' Line of cross section (plate 34)


PC'
NPRR No 17
Gulch
SH-7143'
4141'
4' at 4075'
13' at 4042'
T.D. 180'
BOUNDARY
Gulch
NPRR No 18
SH-7141
4053'
12' at 4011'
17' at 3767'
T.D. 320'
FOREST
NATIONAL
R. 48 E.
Creek
Reservoir
SH-7117
SONNETTE
P.O
Pumpkin
Run
SH-7119
SH-7139
SS-7
Creek
N


Deadman
South Fork Threemile Creek
T 4 S
SH-7143'
4141'
4' at 4075'
13' at 4042'
T.D. 180'
SH-7142'
4087'
13' at 4047'
6' at 3912'
T.D. 200'
BOUNDARY
SH-7140
O.C.
J I Drilling
Gulch
Skinner
N P R R No 18
SH-7141
4053'
12' at 4011'
17' at 3767'
T.D. 320'
FOREST
Creek
SH-7050
Tenmile Creek
NATIONAL
SH-7117
Rain
SH-7139
SH-7138
T 5 S
SH-7137 A
SH-7137
CUSTER
Fifteenmile
Creek
SH-7047
3918'
4' at 3891'
17' at 3778'
T.D. 205'
SH-7136
3984'
6' at 3939'
19' at 3762'
11' at 3705'
T.D. 358'

Base map from U.S.G.S. 7 1/2 minute series topographic maps.
Home Creek Butte, Threemile Buttes, Sonnette

C


Gulch
Gulch
N P R R No 18
SH-7141
4053'
12' at 4011'
17' at 3767'
T.D. 320'
FOREST
BOUNDARY
NATIONAL
R 48 E
Creek
Reservoir
Creek
Pumpkin
Sugar
Run
SONNETE
P.O.
SH-7117
SH-7119
SS-7
SH-7118
4066'
7' at 4029'
10' at 3988'
T.D. 100'
Creek
SS-3
T 5 S
N

▆ 0-50' of overburden
░ 50'-100' " "
▒ 100'-150' " "

FERRY BED

▆ 0-50' of overburden
▨ 50'-100' " "

◇ Oil well drill hole

● M.B.M.G. drill hole

SH-7143	hole designation
4141'	altitude at top of collar
13' at 4042'	altitude at top of 13' of coal
T.D. 180'	total depth of drill hole

Clinker and outcrop mapped by J. W. Blumer, from colored and black and white aerial photographs

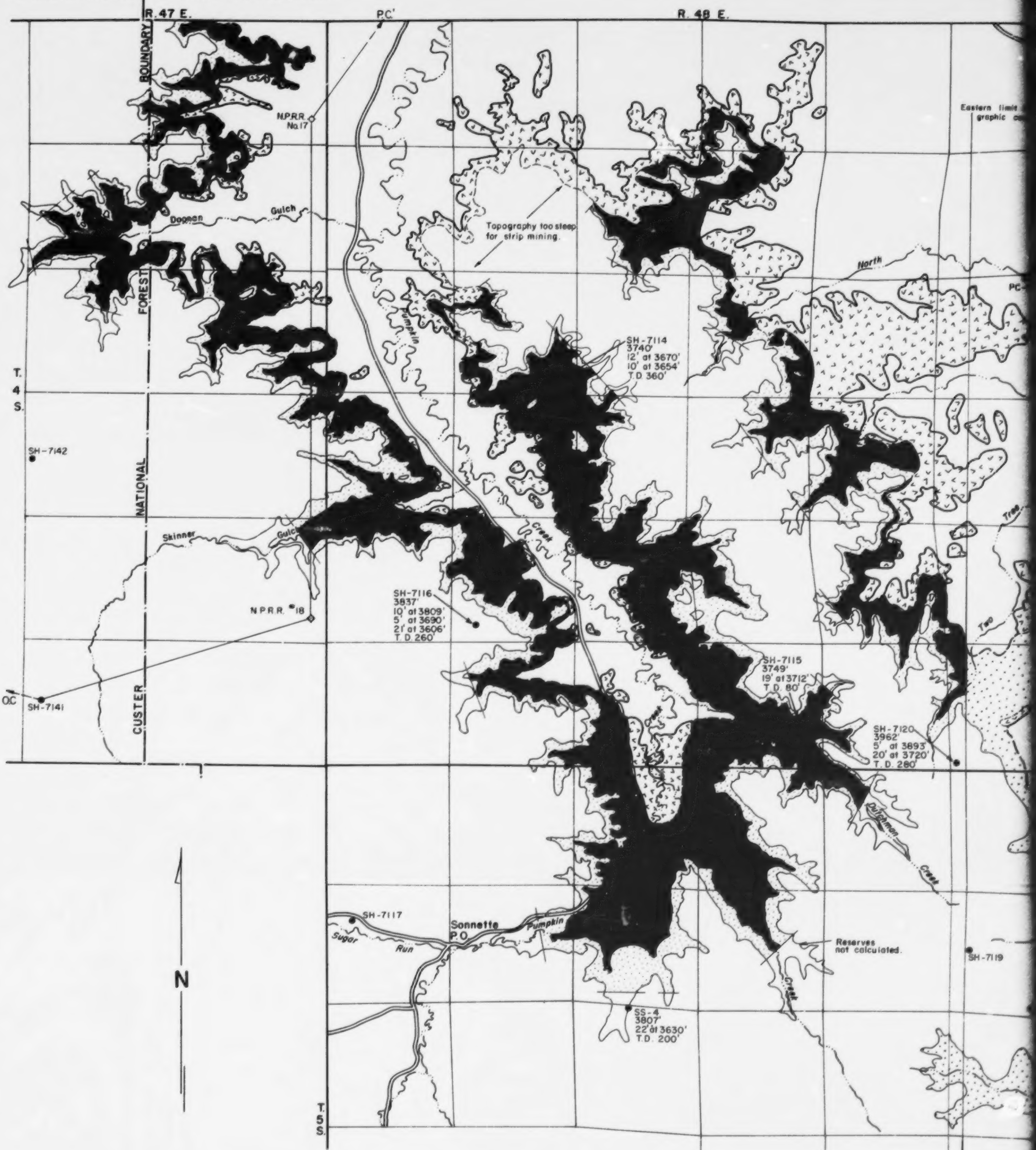
OC ——— PC' Line of cross section (plate 34)

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - M. J. Daniels

D

A

MONTANA BUREAU OF MINES AND GEOLOGY



R. 47 E.
R. 48 E.
P.C'
BOUNDARY
FOREST
NATIONAL
CUSTER
N.P.R.R. No.17
N.P.R.R. 18
O.C
SH-7141
SH-7142
T. 4 S.
T. 5 S.
Doonan Gulch
Skinner Gulch
Pumpkin Creek
Topography too steep for strip mining.
Eastern limit graphic c
North
PC-
Tree
Two
SH-7114 3740' 12' at 3670' 10' at 3654' T.D. 360'
SH-7116 3837' 10' at 3809' 5' at 3690' 21' at 3606' T.D. 260'
SH-7115 3749' 19' at 3712' T.D. 80'
SH-7120 3962' 5' at 3893' 20' at 3720' T.D. 280'
Dutchman Creek
Reserves not calculated.
SH-7119
SH-7117
Sonnette P.O.
Sugar Run
Pumpkin
Creek
SS-4 3807' 22' at 3630' T.D. 200'
N
SH-7118

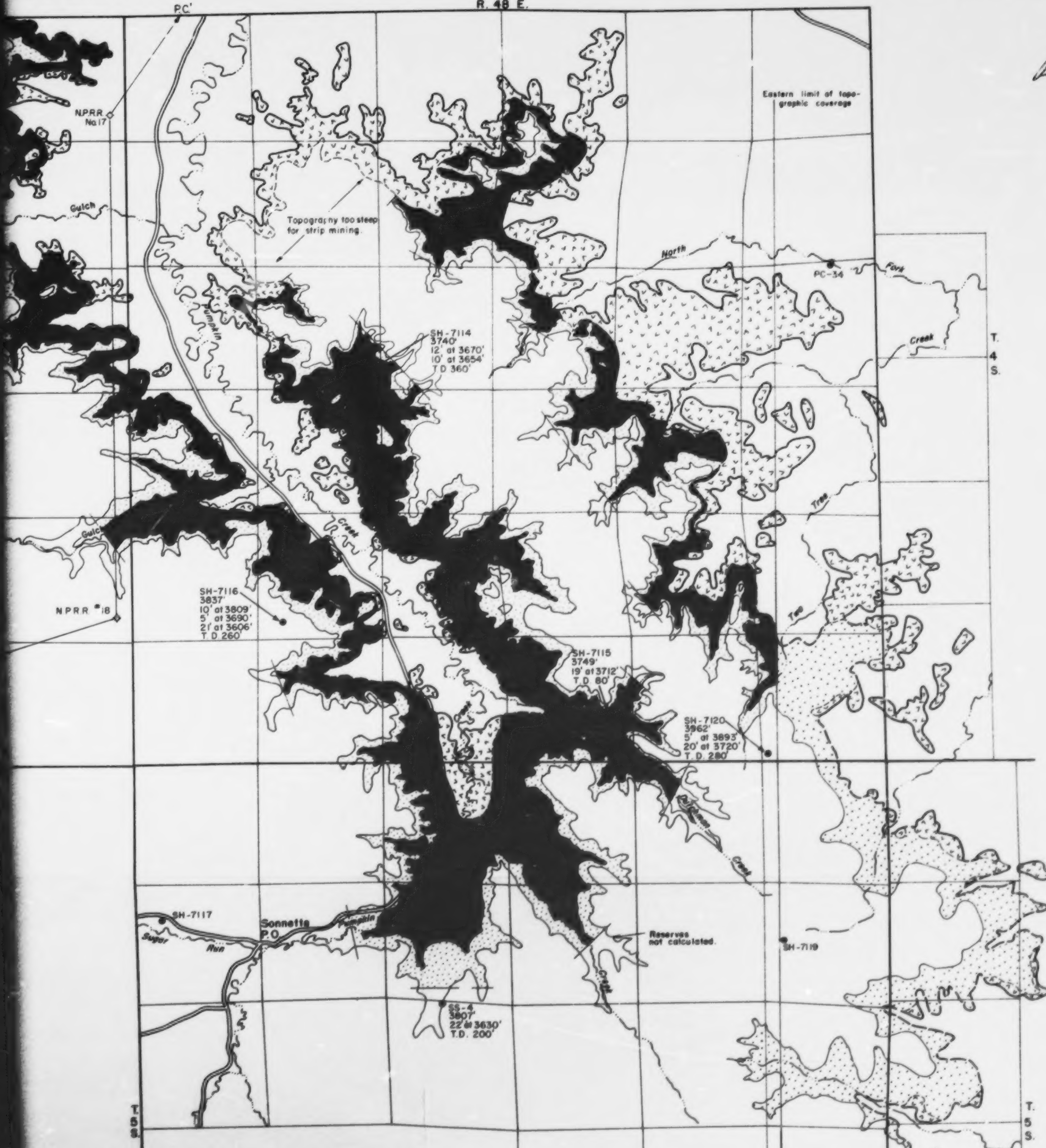
MAP OF

SONNETTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE PAWNEE COAL BED,

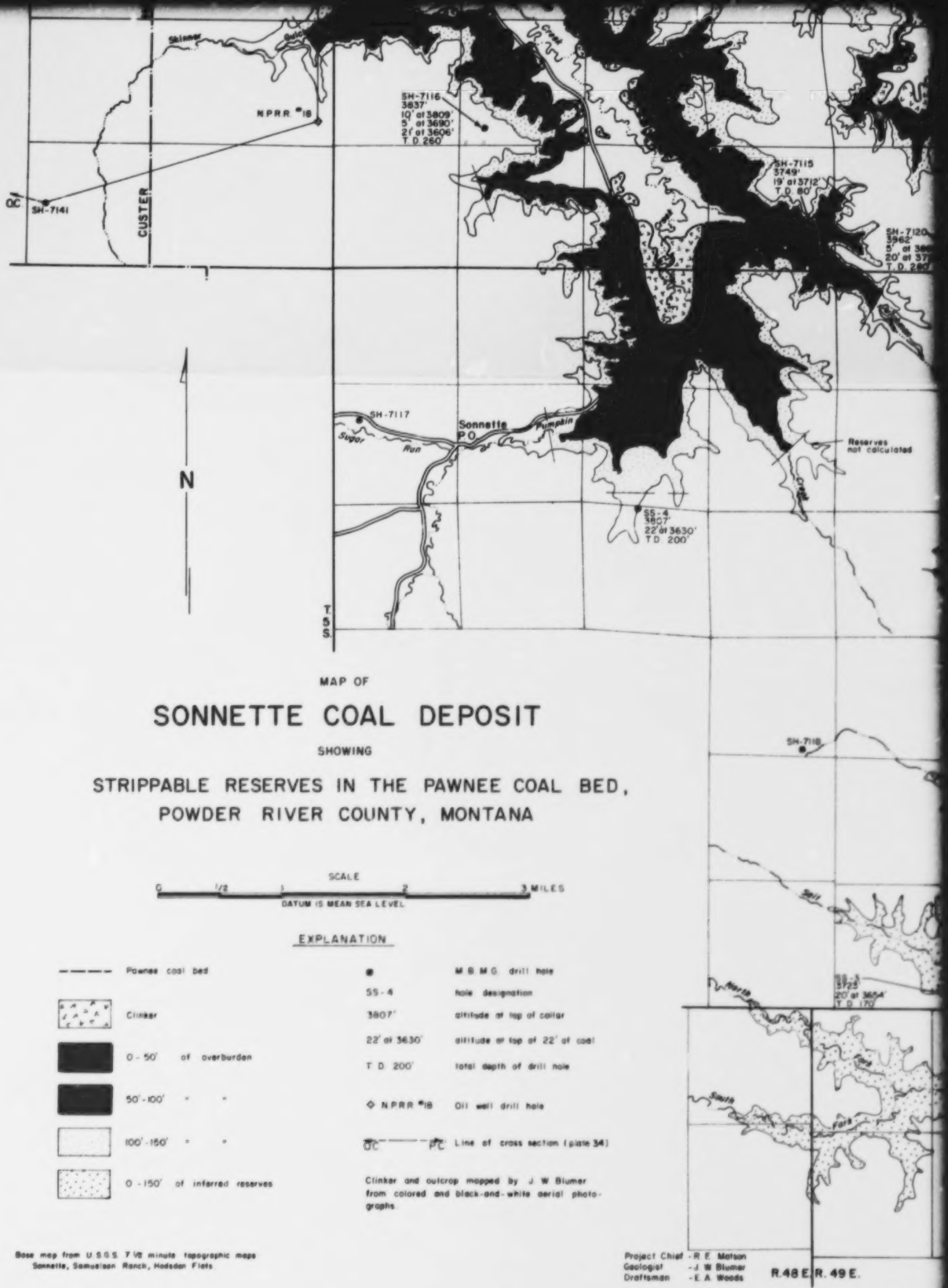
B


R. 48 E.
P.C'
N.P.R.R. No.17
Gulch
Topography too steep for strip mining.
Eastern limit of topographic coverage
North
PC-34
Fork
Creek
T. 4 S.
Pumpkin
SH-7114
3740'
12' at 3670'
10' at 3654'
T.D 360'
Creek
Gulch
SH-7116
3837'
10' at 3809'
5' at 3690'
21' at 3606'
T.D. 260'
NPRR 18
Tree
Two
SH-7115
3749'
19' at 3712'
T.D. 80'
SH-7120
3962'
5' at 3893'
20' at 3720'
T.D. 280'
Creek
SH-7117
Sonnette P.O.
Sugar
Run
Pumpkin
Reserves not calculated.
SH-7119
Creek
SS-4
3807'
22' at 3630'
T.D. 200'
T. 5 S.
T. 5 S.
SH-7118

MAP OF

NETTE COAL DEPOSIT

SHOWING


Skinner
Gulch
Creek
N.P.R.R. #18
SH-7116
3837'
10' at 3809'
5' at 3690'
2' at 3606'
T.D. 260'
OC
SH-7141
CUSTER
SH-7115
3749'
19' at 3712'
T.D. 80'
SH-7120
3962'
5' at 38
20' at 37
T.D. 280'
N
SH-7117
Sonnette
P.O.
Sugar
Run
Pumpkin
Reserves
not calculated
Creek
SS-4
3807'
22' at 3630'
T.D. 200'
T.
5
S.
SH-7118
SS-3
3725'
20' at 3604'
T.D. 170
North Fork
South Fork
Fork
R.48 E. R.49 E.

MAP OF

SONNETTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE PAWNEE COAL BED, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

— — —	Pawnee coal bed
▨	Clinker
■	0 - 50' of overburden
■	50'-100' " "
☐	100'-150' " "
⁘	0 - 150' of inferred reserves

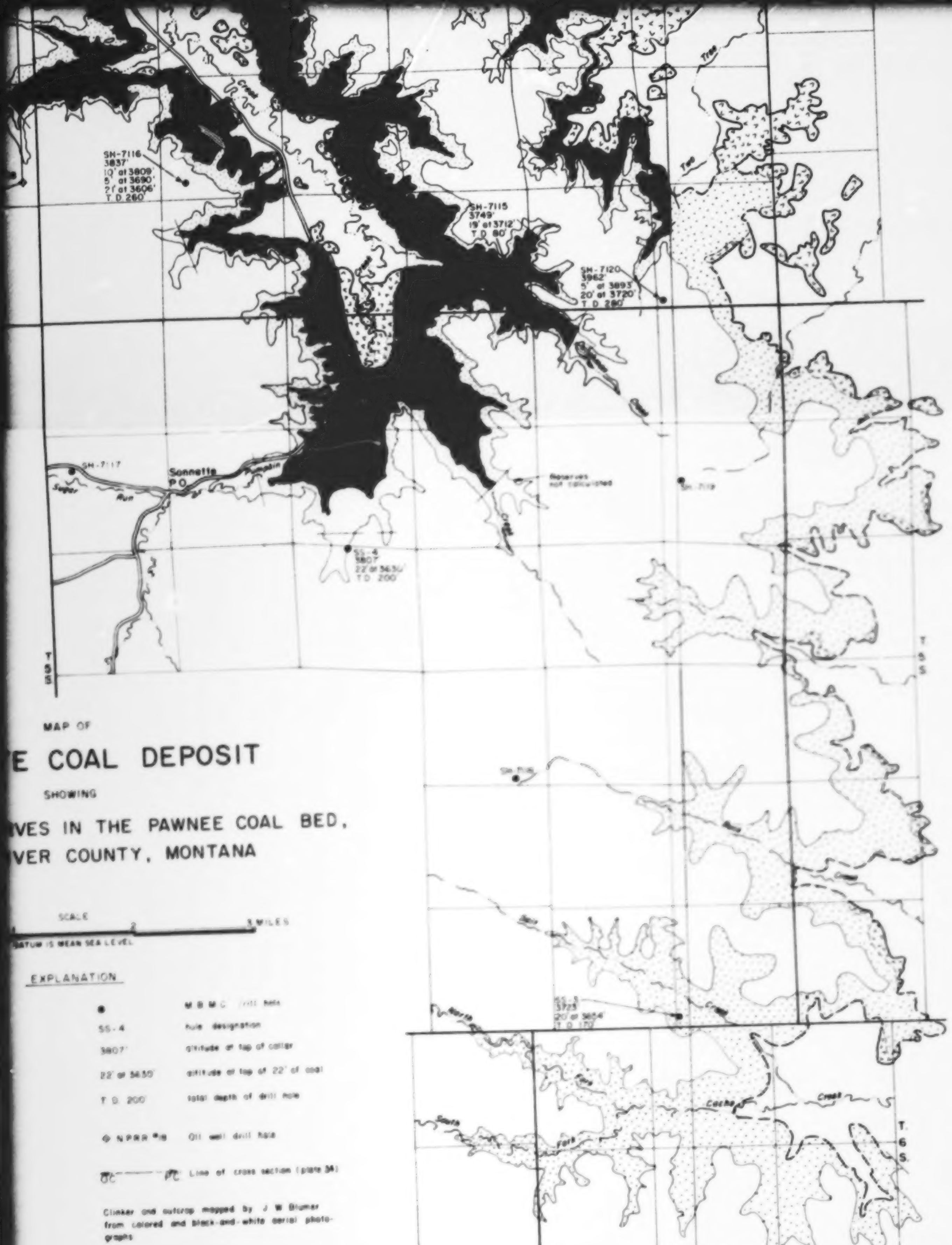
●	M.B.M.G. drill hole
SS-4	hole designation
3807'	altitude at top of collar
22' at 3630'	altitude at top of 22' of coal
T.D. 200'	total depth of drill hole
◇ N.P.R.R. #18	Oil well drill hole
OC ——— PC	Line of cross section (plate 34)

Clinker and outcrop mapped by J. W. Blumer from colored and black-and-white aerial photographs.

Base map from U.S.G.S. 7 1/2 minute topographic maps
Sonnette, Samuelson Ranch, Hodsdon Flats

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

d


SH-7116
3837'
10' at 3809'
5' at 3690'
21' at 3606'
T.D. 260'
SH-7115
3749'
19' at 3712'
T.D. 80'
SH-7120
3962'
5' at 3893'
20' at 3720'
T.D. 280'
Creek
Tree
Two
SH-7117
Sonnette
P.O.
Sugar
Run
Pumpkin
Reserves
not calculated
SH-7119
Creek
SS-4
3807'
22' at 3630'
T.D. 200'
T.
5
S.
T.
5
S.
SH-7118
SS-5
20' at 3654'
North
Fork
South
Fork
Cache
Creek
T.
6
S.
Eastern limit of topographic coverage
R.48 E.
R. 49 E.

MAP OF

E COAL DEPOSIT

SHOWING

IVES IN THE PAWNEE COAL BED,
IVER COUNTY, MONTANA

SCALE

2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

●	M.B.M.C. drill hole
SS-4	hole designation
3807'	altitude at top of collar
22' at 3630'	altitude at top of 22' of coal
T.D. 200'	total depth of drill hole
⊕ N.P.R.R. #18	Oil well drill hole
OC ——— PC	Line of cross section (plate 34)

Clinker and outcrop mapped by J. W. Blumer from colored and black-and-white aerial photographs

Project Chief - R. E. Morgan
Geologist - J. W. Blumer
Draftsman - E. A. Woods

D

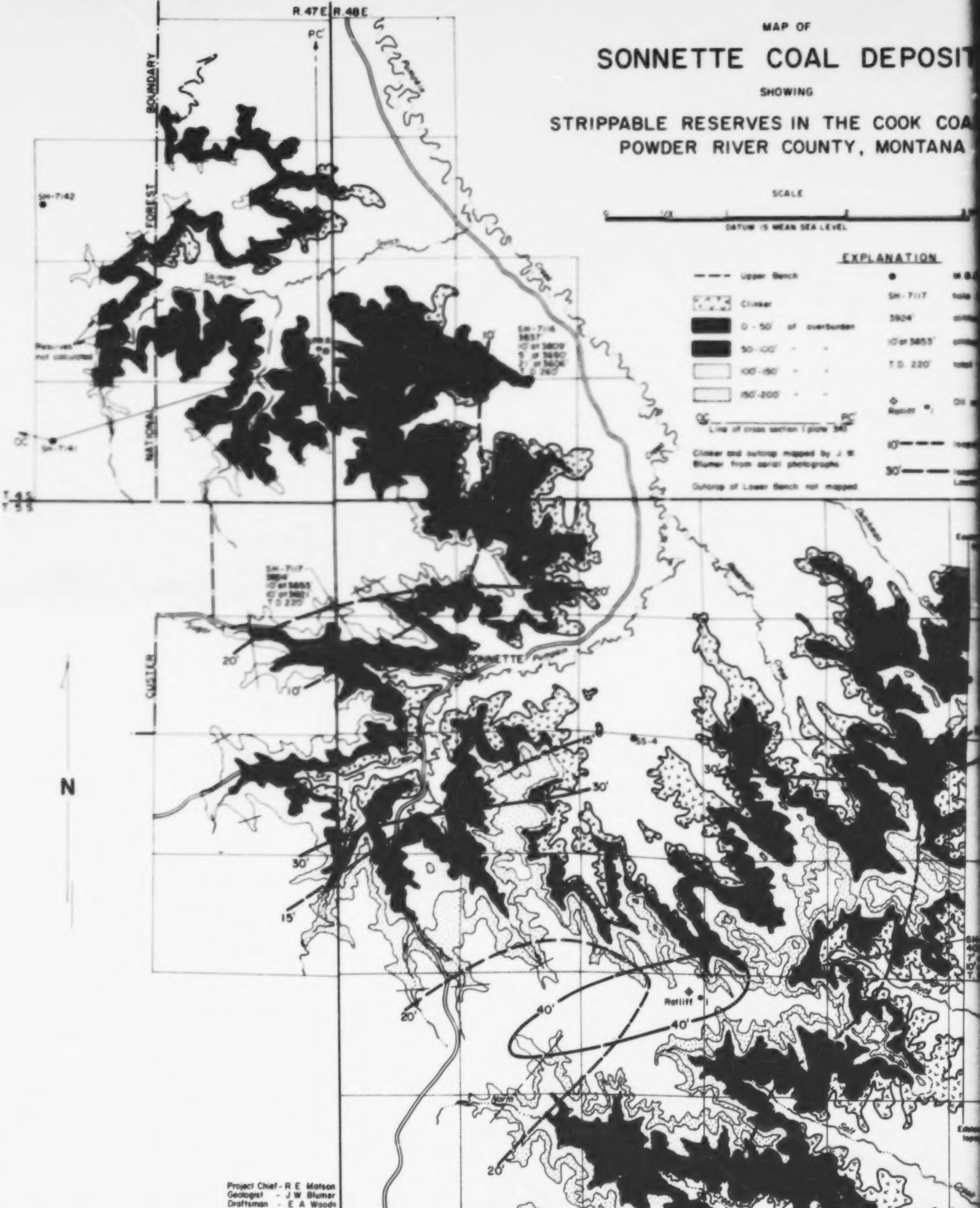
12

MAP OF

SONNETTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE COOK COA
POWDER RIVER COUNTY, MONTANA


SCALE
0
1/2
1
2
DATUM IS MEAN SEA LEVEL
EXPLANATION
Upper Bench
Clinker
0 - 50' of overburden
50-100' " "
100'-150' " "
150'-200' " "
QC' PC'
Line of cross section (plate 34)
Clinker and outcrop mapped by J. W. Blumer from aerial photographs
Outcrop of Lower Bench not mapped
SH-7117
3924'
10' at 3853'
T.D. 220'
Ratliff
10'
30'
R.47 E.
R.48 E.
PC'
FOREST BOUNDARY
NATIONAL
CUSTER
SH-7142
SH-7141
SH-7116
SH-7117
Reserves not calculated
T.4 S.
T.5 S.
SONNETTE
SS-4
N
20'
10'
15'
30'
40'
Ratliff
R. 48 E.

Project Chief - R E Matson
Geologist - J W Blumer
Draftsman - E A Woods

Base map from U.S.G.S. 7 1/2 minute topographic maps Threemile Buttes and Sonnette

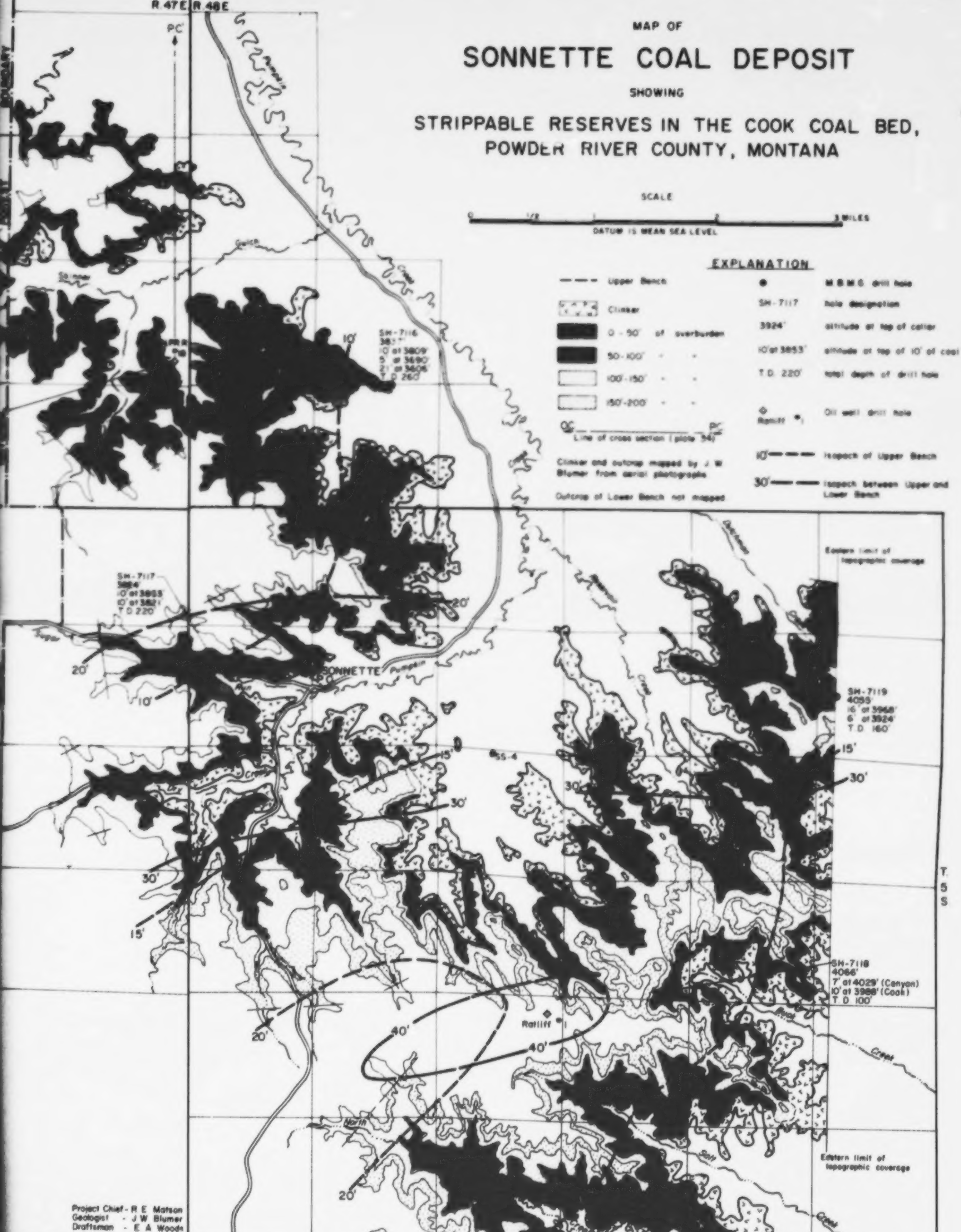
B

MAP OF

SONNETTE COAL DEPOSIT

SHOWING

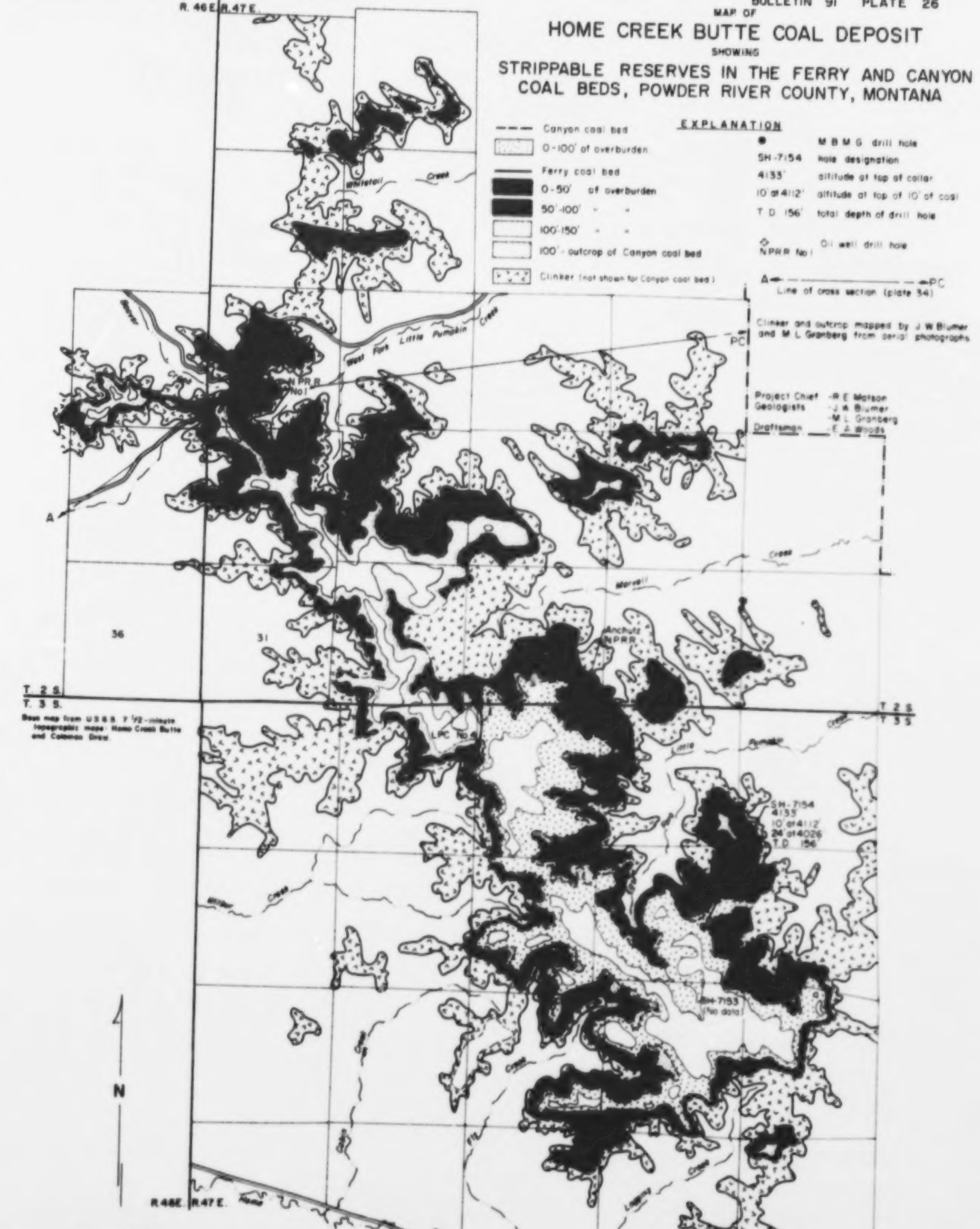
STRIPPABLE RESERVES IN THE COOK COAL BED, POWDER RIVER COUNTY, MONTANA


R.47E
R.48E
PC'
PC
SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL
EXPLANATION
Upper Bench
Clinker
0 - 50' of overburden
50-100' " "
100'-150' " "
150'-200' " "
Line of cross section (plate 34)
Clinker and outcrop mapped by J W Blumer from aerial photographs
Outcrop of Lower Bench not mapped
M B M G drill hole
SH-7117 hole designation
3924' altitude at top of collar
10' at 3853' altitude at top of 10' of coal
T.D. 220' total depth of drill hole
Ratliff Oil well drill hole
10' Isopach of Upper Bench
30' Isopach between Upper and Lower Bench
SH-7116
3837'
10' at 3809'
5' at 3690'
21' at 3606'
T.D. 260'
SH-7117
3884'
10' at 3863'
10' at 3821'
T.D. 220'
SH-7119
4059'
16' at 3968'
6' at 3924'
T.D. 160'
SH-7118
4066'
7' at 4029' (Canyon)
10' at 3988' (Cook)
T.D. 100'
SONNETTE
Pumpkin
Creek
Sugar
Gulch
North
Salt
Ratliff
SS-4
SS-3
Eastern limit of topographic coverage
Eastern limit of topographic coverage
T. 5 S
R. 48 E.
10'
15'
20'
30'
40'
Project Chief - R E Matson
Geologist - J W Blumer
Draftsman - E A Woods
topographic maps

MONTANA BUREAU OF MINES AND GEOLOGY

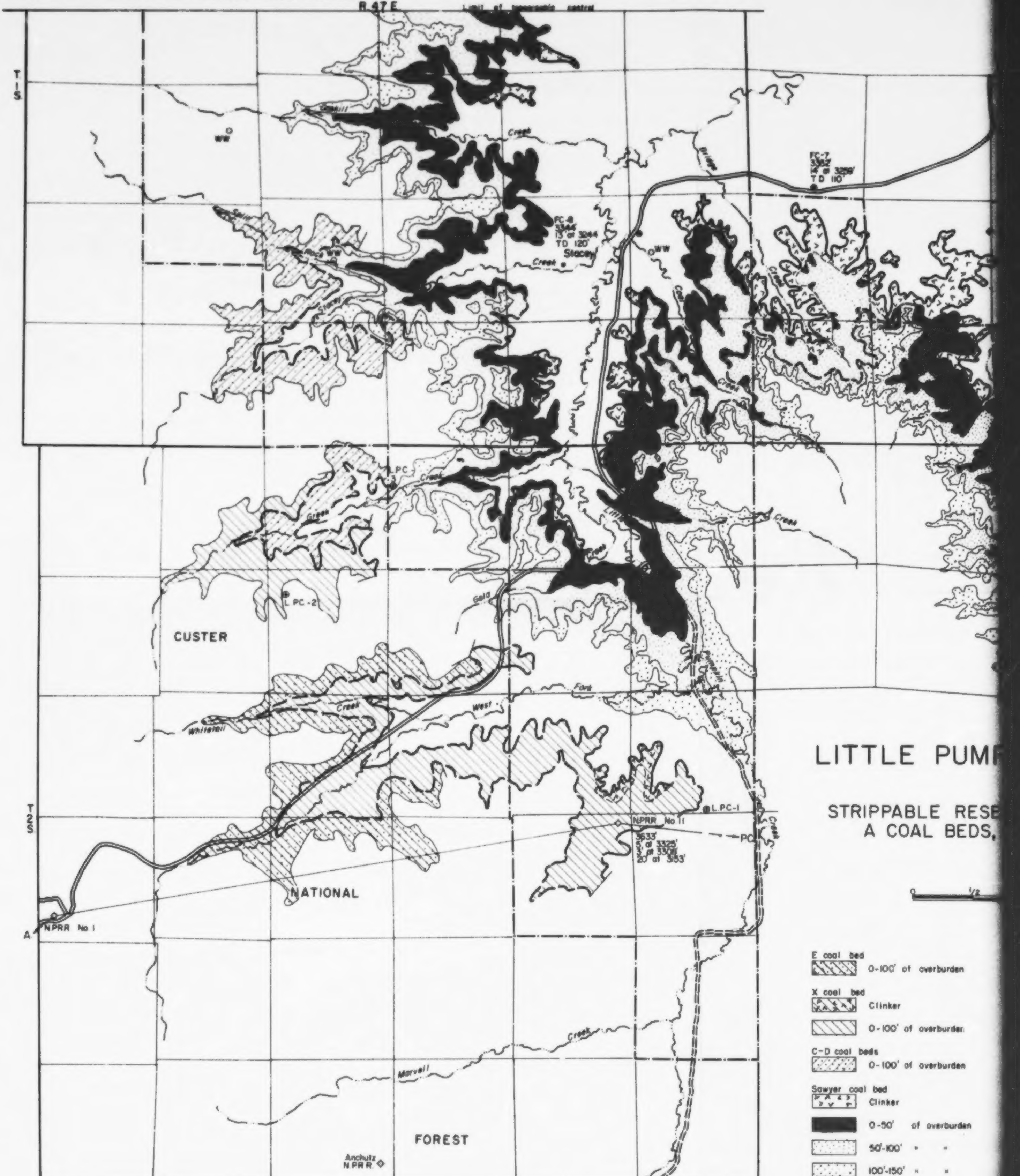
BULLETIN 91 PLATE 26

MAP OF
HOME CREEK BUTTE COAL DEPOSIT
SHOWING
STRIPPABLE RESERVES IN THE FERRY AND CANYON COAL BEDS, POWDER RIVER COUNTY, MONTANA


EXPLANATION
Canyon coal bed
0-100' of overburden
Ferry coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
100' - outcrop of Canyon coal bed
Clinker (not shown for Canyon coal bed)
M B M G drill hole
SH-7154 hole designation
4133' altitude at top of collar
10' at 4112' altitude at top of 10' of coal
T D 156' total depth of drill hole
NPRR No 1 Oil well drill hole
A — PC Line of cross section (plate 34)
Clinker and outcrop mapped by J W Blumer and M L Granberg from aerial photographs
Project Chief - R E Matson
Geologists - J A Blumer
- M L Granberg
Draftsman - E A Woods
R. 46 E. R. 47 E.
T. 2 S.
T. 3 S.
36
31
West Fork Little Pumpkin Creek
NPRR No 1
Anchutz NPRR
LPC No 6
Morell Creek
Little Pumpkin Creek
Whitetail Creek
Miller Creek
SH-7154
4133'
10' at 4112'
24' at 4026'
T D 156'
SH-7153 (No data)
Base map from U.S.G.S. 7 1/2-minute topographic maps: Home Creek Butte and Coleman Draw.
N
R.46E. R.47 E.
Home Creek
Scale
0
1/2
1
2 MILES
DATUM IS MEAN SEA LEVEL

A

MONTANA BUREAU OF MINES AND GEOLOGY


R.47 E.
Limit of topographic control
T.1 S.
T.2 S.
WW
Creek
FC-7
3362
14' at 3259'
TD 110'
FC-8
3344
13' at 3244
TD 120'
Stacey
Creek
WW
Coal
Creek
L.PC
Creek
Little
L.PC-2
Gold
CUSTER
West
Fork
Whitetail
Creek
L.PC-1
NPRR No 11
3633'
5' at 3325'
3' at 3308'
20' at 3153'
PC
Creek
NATIONAL
A
NPRR No 1
Marvell
Creek
FOREST
Anchutz
N.P.R.R.
0
1/2

LITTLE PUMP

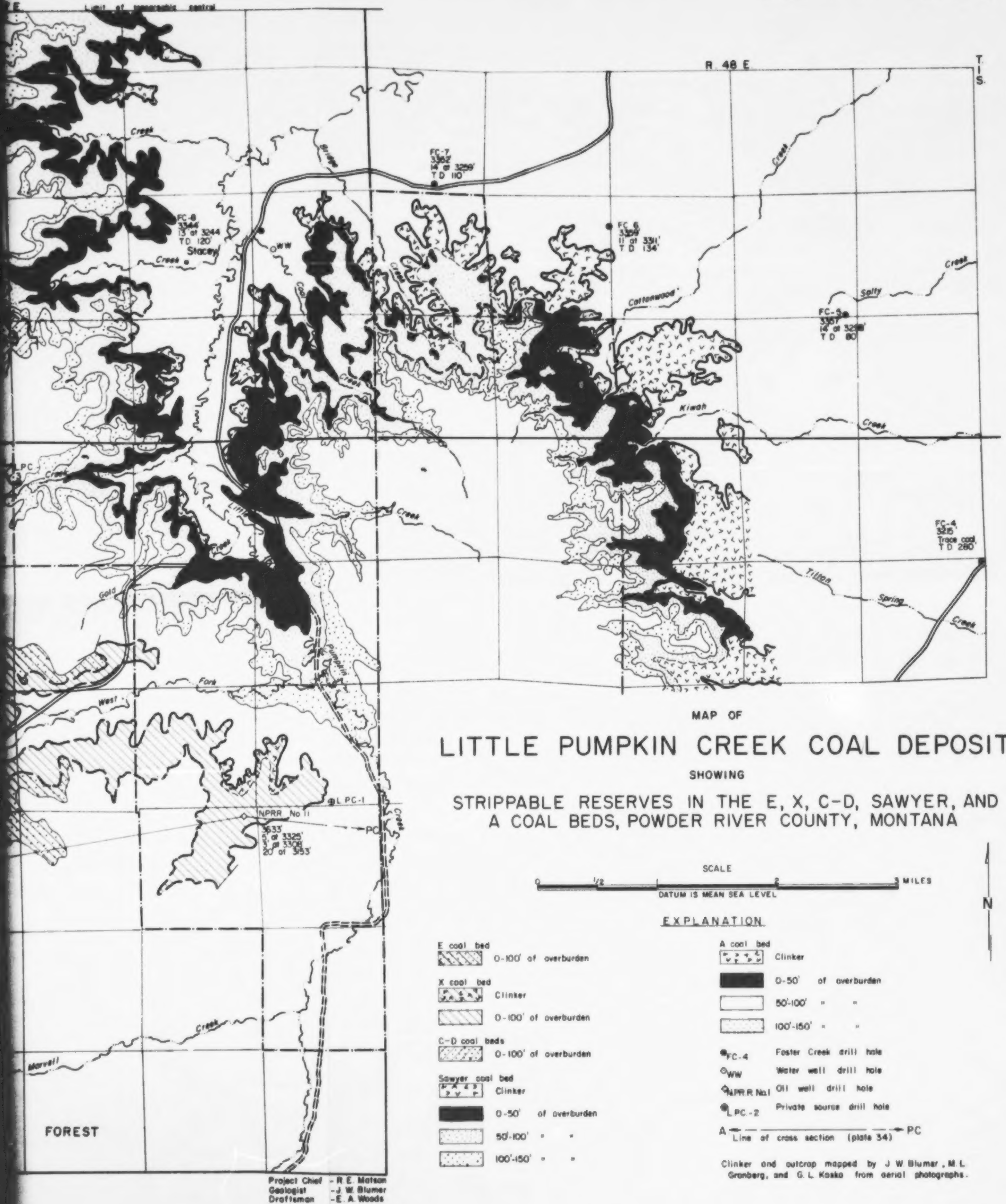
STRIPPABLE RESE
A COAL BEDS,

E coal bed
▨ 0-100' of overburden
X coal bed
Clinker
▨ 0-100' of overburden
C-D coal beds
0-100' of overburden
Sawyer coal bed
Clinker
■ 0-50' of overburden
50'-100' " "
100'-150' " "

Base map from U.S.G.S. 7 1/2-minute topographic maps
Stacey and Elk Ridge.

Project Chief - R.E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

B


Limit of topographic control
R. 48 E.
T. 1 S.
Creek
Bridge
Coal
Creek
Stacey
Creek
FC-8
3344'
13' at 3244'
T D 120'
WW
FC-7
3362'
14' at 3259'
T D 110'
FC-6
3359'
11' at 3311'
T D 134'
Creek
Cottonwood
Creek
Salty
Creek
FC-5
3357'
14' at 3298'
T D 80'
Kiwah
Creek
LPC
Creek
Little
Creek
Creek
Gold
Tilton
Spring
Creek
FC-4
3215'
Trace coal
T D 280'
Pumpkin
Fork
West
L PC-1
NPRR No 11
3633'
5' at 3325'
3' at 3308'
20' at 3153'
PC
Creek
Creek
Marvell
FOREST

MAP OF

LITTLE PUMPKIN CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE E, X, C-D, SAWYER, AND A COAL BEDS, POWDER RIVER COUNTY, MONTANA

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

N

EXPLANATION

E coal bed
▨ 0-100' of overburden

X coal bed
▨ Clinker
▨ 0-100' of overburden

C-D coal beds
▨ 0-100' of overburden

Sawyer coal bed
▨ Clinker
■ 0-50' of overburden
░ 50'-100' " "
░ 100'-150' " "

A coal bed
▨ Clinker
■ 0-50' of overburden
□ 50'-100' " "
░ 100'-150' " "

● FC-4 Foster Creek drill hole
○ WW Water well drill hole
◇ NPR.R. No.1 Oil well drill hole
● L PC.-2 Private source drill hole

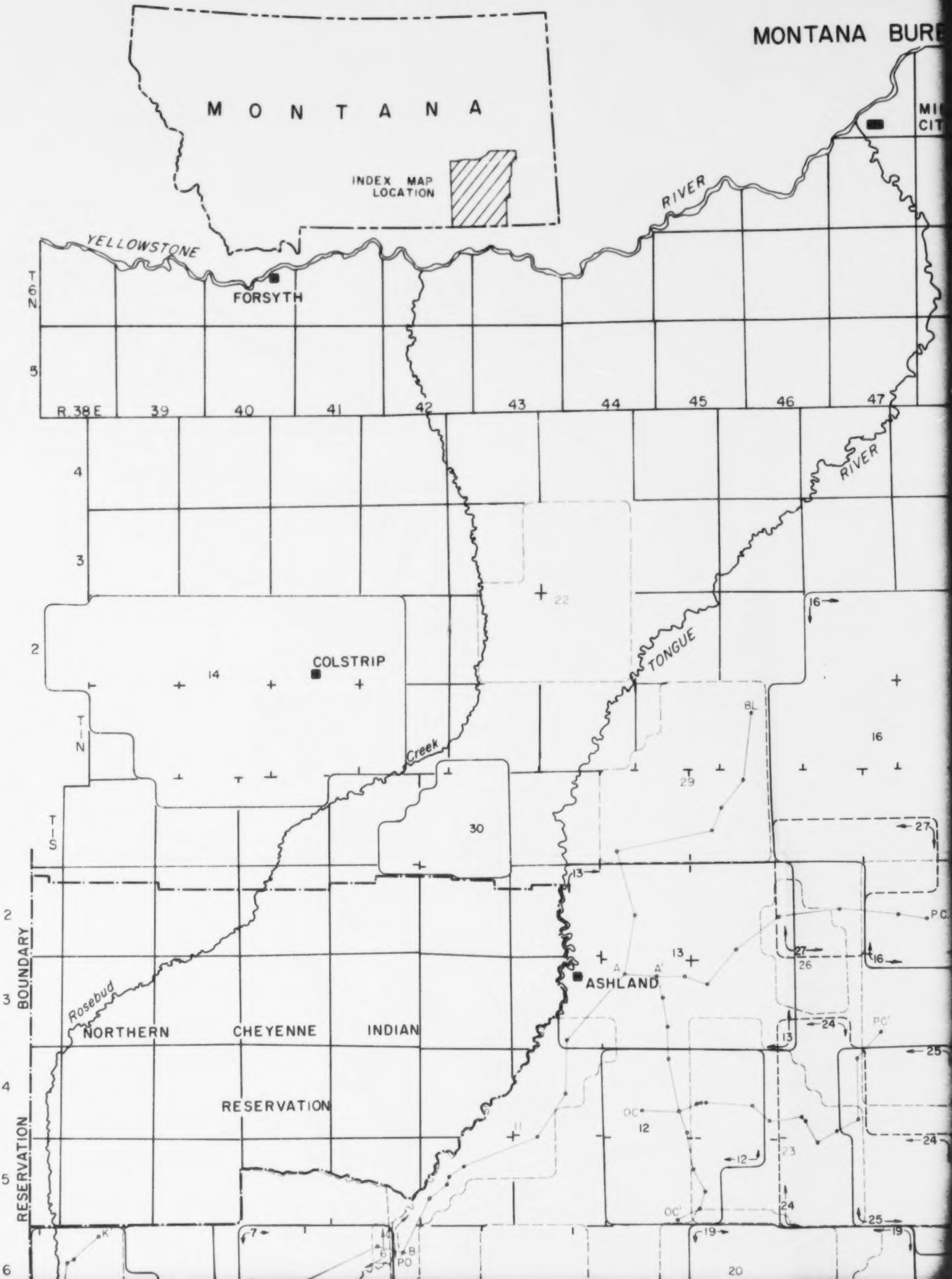
A ← — —— — → PC
Line of cross section (plate 34)

Clinker and outcrop mapped by J. W. Blumer, M. L. Gronberg, and G. L. Kasko from aerial photographs.

Project Chief - R. E. Matson
Geologist - J. W. Blumer
Draftsman - E. A. Woods

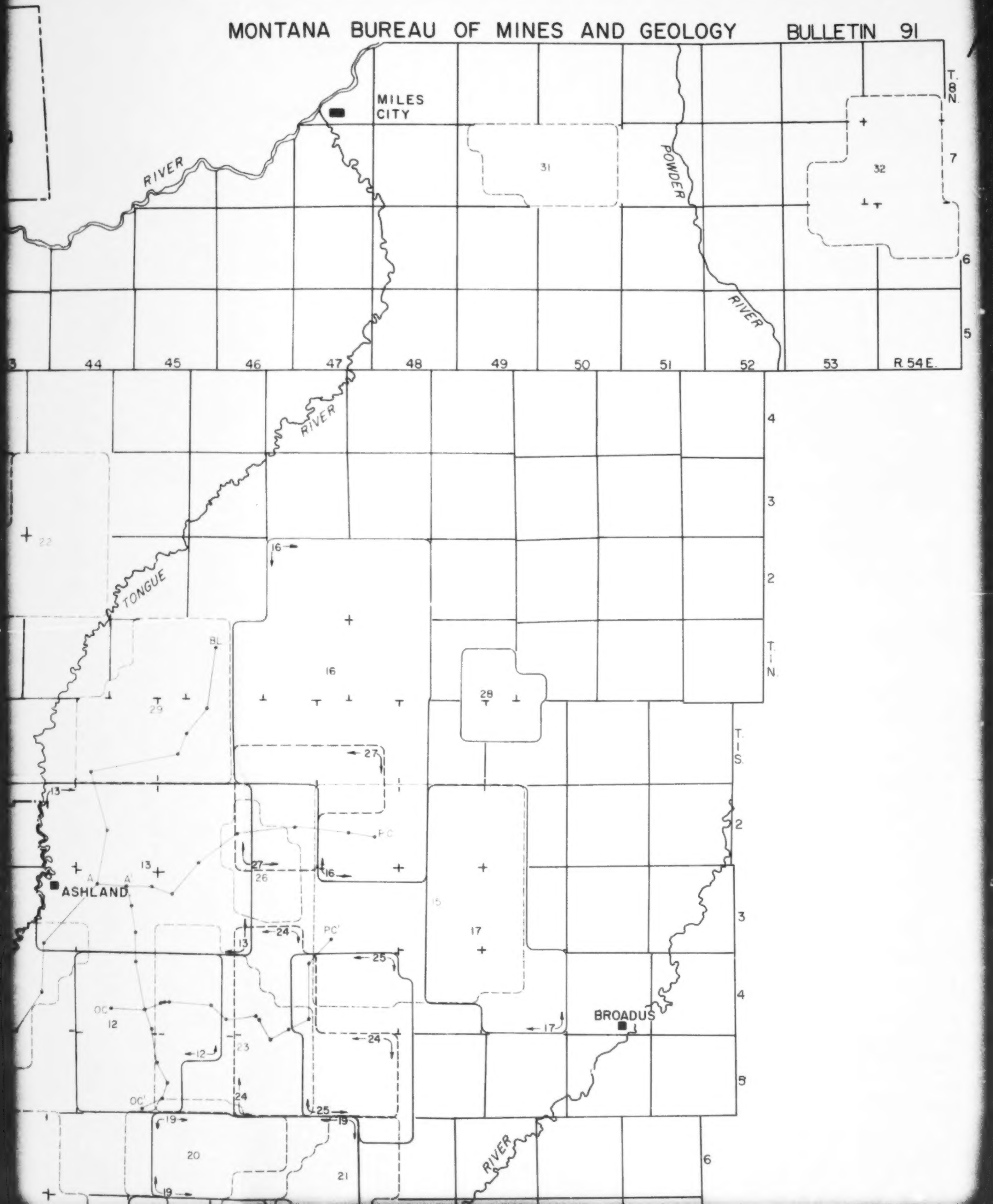
A

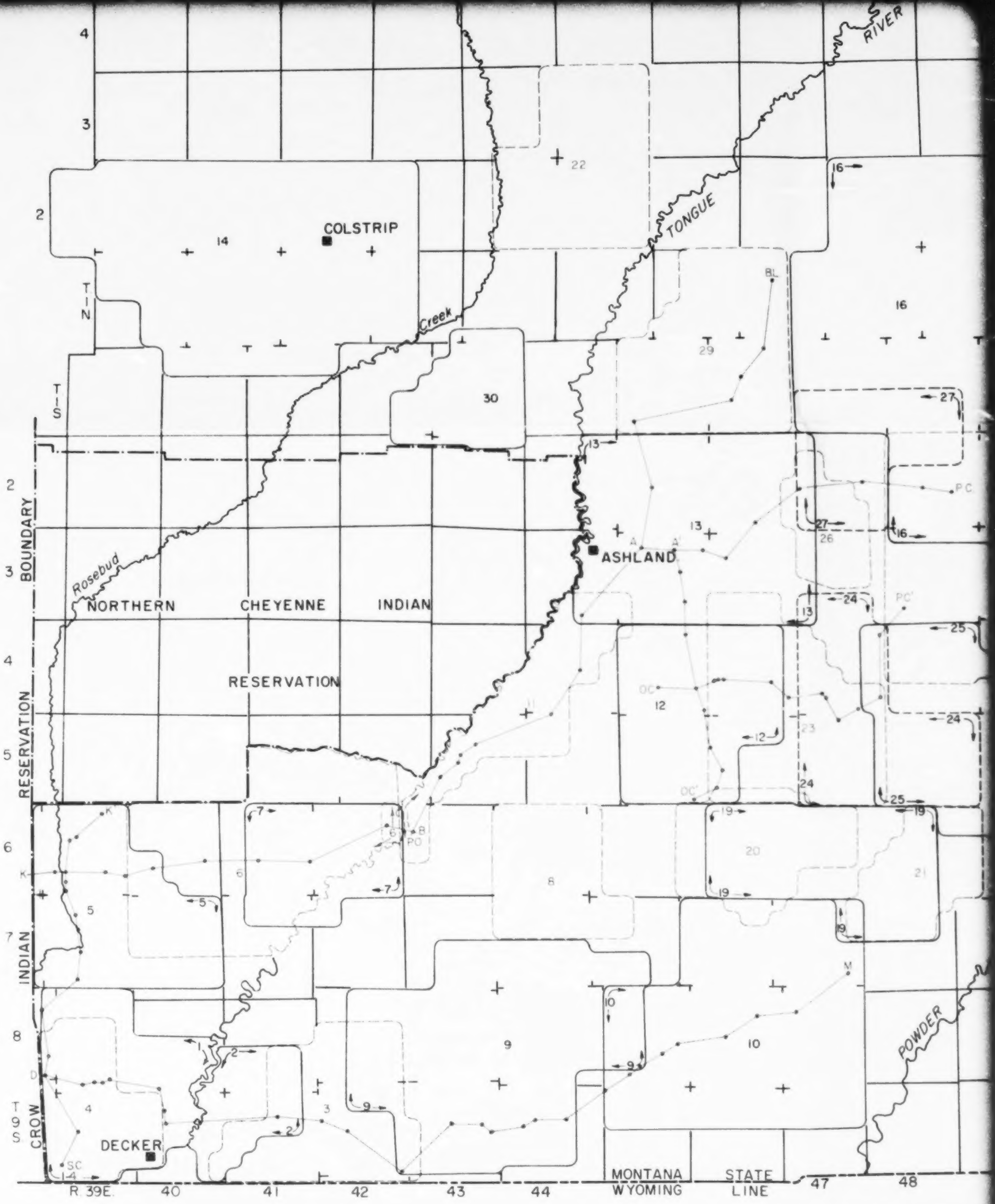
MONTANA BURE



MONTANA
INDEX MAP LOCATION
MI
CIT
YELLOWSTONE
RIVER
T 6 N
FORSYTH
5
R. 38 E
39
40
41
42
43
44
45
46
47
4
3
2
RIVER
TONGUE
22
COLSTRIP
14
16
BL
29
T 1 N
Creek
30
27
T 1 S
13
2
PC
27
26
16
ASHLAND
A
A'
13
3
Rosebud
NORTHERN
CHEYENNE
INDIAN
24
PC'
13
25
BOUNDARY
4
RESERVATION
OC
12
11
24
23
12
5
RESERVATION
24
OC'
25
19
7
19
6
B
PO
K
20
6

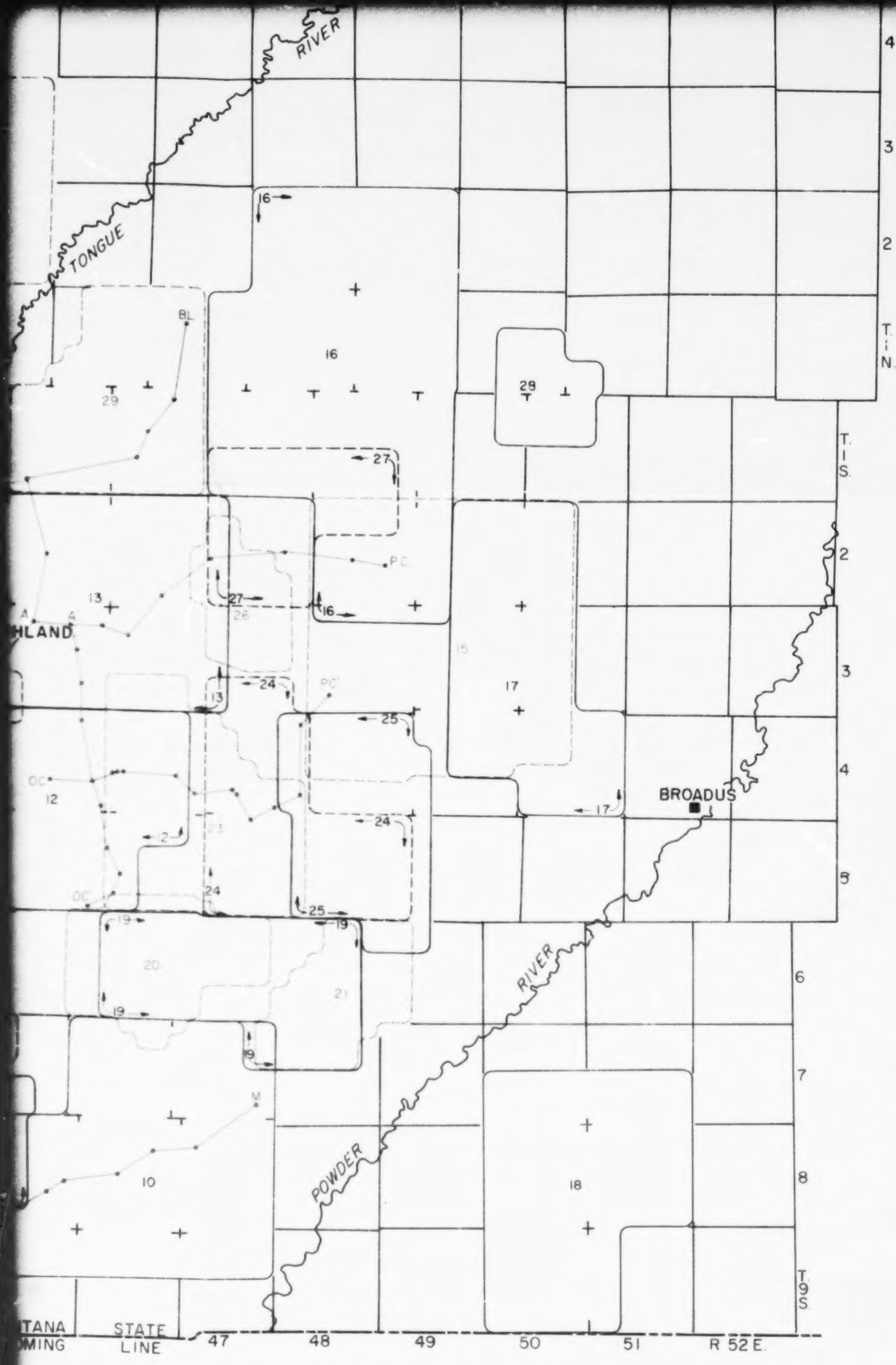
MONTANA BUREAU OF MINES AND GEOLOGY BULLETIN 91


MILES CITY
RIVER
POWDER RIVER
TONGUE RIVER
RIVER
ASHLAND
BROADUS
T. 8 N.
7
6
5
4
3
2
T. 1 N.
T. 1 S.
2
3
4
5
6
43
44
45
46
47
48
49
50
51
52
53
R 54 E.
31
32
22
16
28
29
BL
13
27
26
PC
PC'
A
A'
15
17
24
25
12
OC
OC'
23
19
20
21

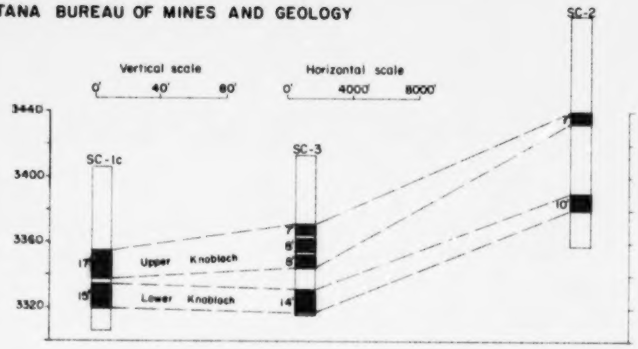

4
3
2
COLSTRIP
14
22
TONGUE
RIVER
Rosebud
Creek
T 1 N
T 1 S
16
29
BL
30
27
13
2
3
4
5
6
7
8
T 9 S
A
A'
ASHLAND
PC
PC'
26
24
25
NORTHERN CHEYENNE INDIAN RESERVATION
RESERVATION BOUNDARY
CROW INDIAN
12
OC
OC'
23
11
K
K'
5
6
7
B
PO
8
19
20
21
9
10
M
1
2
3
4
D
SC
1-4
DECKER
POWDER
MONTANA WYOMING STATE LINE
R. 39E.
40
41
42
43
44
47
48

INDEX TO AREAS SHOWN ON CORRESP
PLATES AND TO LINES OF CROS

C


RIVER
TONGUE
4
3
2
T. 1 N.
T. 1 S.
2
3
4
5
6
7
8
T. 9 S.
16
29
BL
28
27
PC
13
27
26
16
A
A'
HLAND
15
17
24
PC'
13
25
OC
12
23
24
12
OC'
24
25
19
19
20
21
19
19
M
10
18
BROADUS
17
RIVER
POWDER
NTANA
OMING
STATE
LINE
47
48
49
50
51
R 52 E.

OWN ON CORRESPONDINGLY NUMBERED
D LINES OF CROSS SECTIONS


Vertical scale
0' 40' 80'
Horizontal scale
0' 4000' 8000'
3440
3400
3360
3320
SC-1c
SC-3
SC-2
17'
15'
Upper Knobloch
Lower Knobloch
7'
8'
8'
14'
7'
10'

MAP OF

SAND CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED
CUSTER AND POWDER RIVER COUNTIES, MONTANA

SCALE

0 1/2 1 2 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

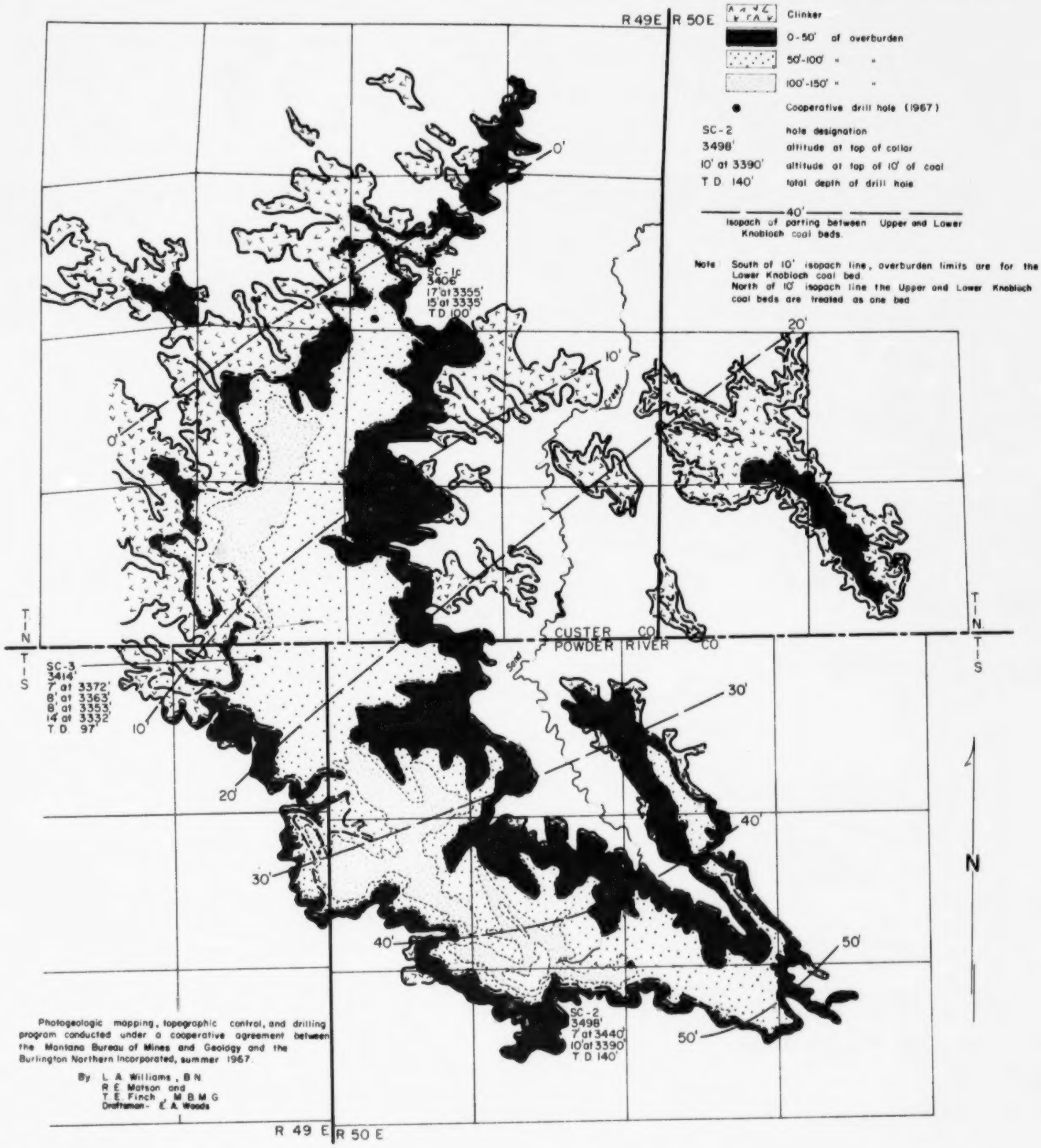
Upper Knobloch coal bed — — — — — — — —

Lower Knobloch coal bed ——— ——— ——— ———

ᐱ ᐱ ᐱ	Clinker
■	0-50' of overburden
⁙	50'-100' " "
░	100'-150' " "
●	Cooperative drill hole (1967)
SC-2	hole designation
3498'	altitude at top of collar
10' at 3390'	altitude at top of 10' of coal
T D 140'	total depth of drill hole

——— ———40'——— ——— ———
Isopach of parting between Upper and Lower Knobloch coal beds.

Note South of 10' isopach line, overburden limits are for the Lower Knobloch coal bed.
North of 10' isopach line the Upper and Lower Knobloch coal beds are treated as one bed


R 49E
R 50E
0'
SC-1c
3406'
17' at 3355'
15' at 3335'
T D 100'
20'
10'
0'
Creek
T 1 N
T 1 S
CUSTER CO
POWDER RIVER CO
Sand
SC-3
3414'
7' at 3372'
8' at 3363'
8' at 3353'
14 at 3332'
T D 97'
10'
30'
20'
40'
30'
N
40'
50'
50'
SC-2
3498'
7' at 3440'
10' at 3390'
T D 140'
R 49 E
R 50 E

Photogeologic mapping, topographic control, and drilling program conducted under a cooperative agreement between the Montana Bureau of Mines and Geology and the Burlington Northern Incorporated, summer 1967.

By L A Williams, B N
R E Matson and
T E Finch, M B M G
Draftsman- E A Woods

A

MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

BEAVER CREEK - LISCOM CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE TERRET, FLOWER-GOODALE, AND KNOBLOCH COAL BEDS, POWDER RIVER AND CUSTER COUNTIES, MONTANA

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

—— — Coal beds

Knobloch coal bed

▨	Clinker
■	0 - 50' of overburden
▨	50'- 100' " "
☐	100'-150' " "

Flower - Goodale coal bed

▨	Clinker
▨	0 - 50' of overburden
▨	50 - 100' " "

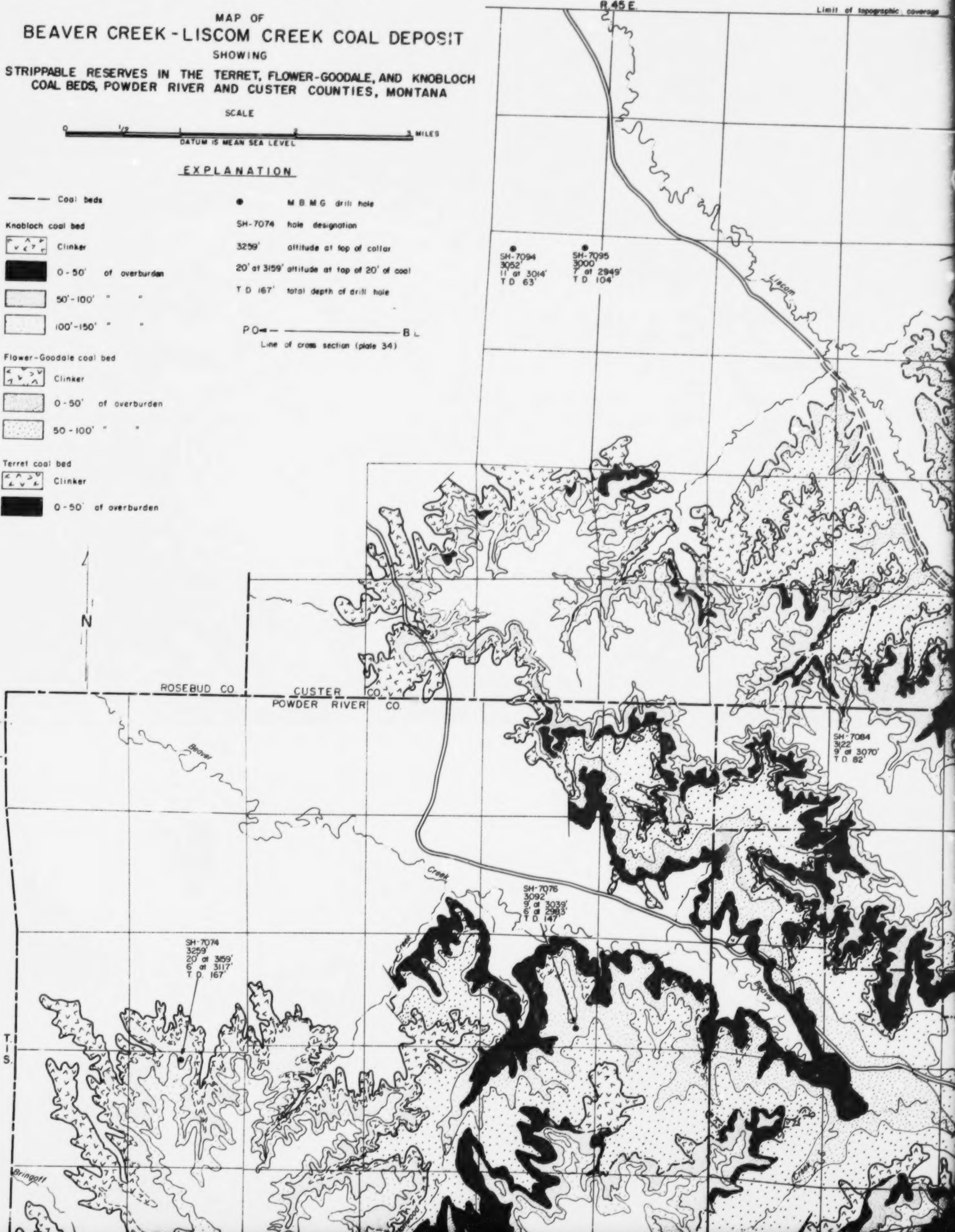
Terret coal bed

▨	Clinker
■	0 - 50' of overburden

●	M B M G drill hole
SH-7074	hole designation
3259'	altitude at top of collar
20' at 3159'	altitude at top of 20' of coal
T D 167'	total depth of drill hole

PO ←— ———— B L

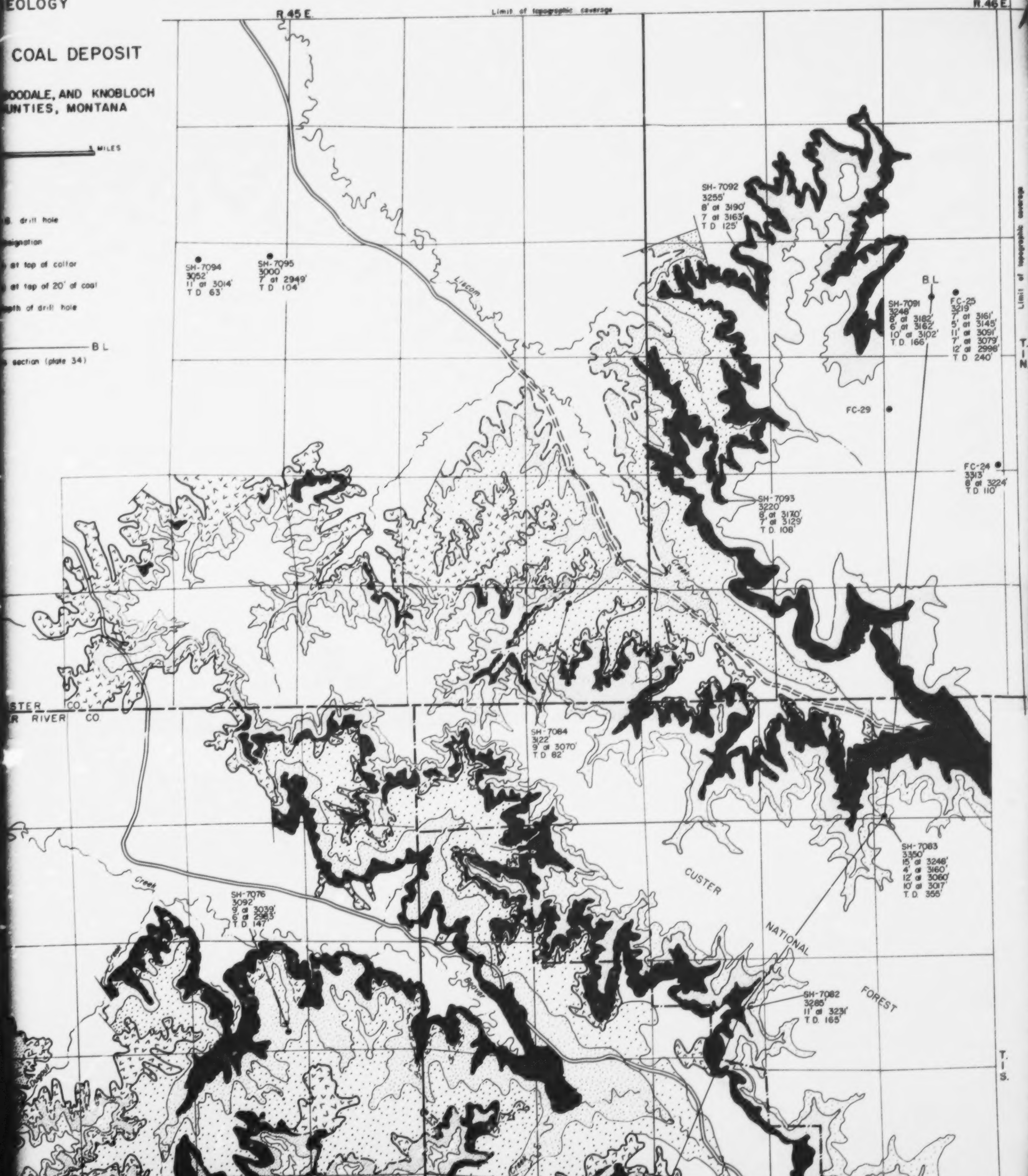
Line of cross section (plate 34)

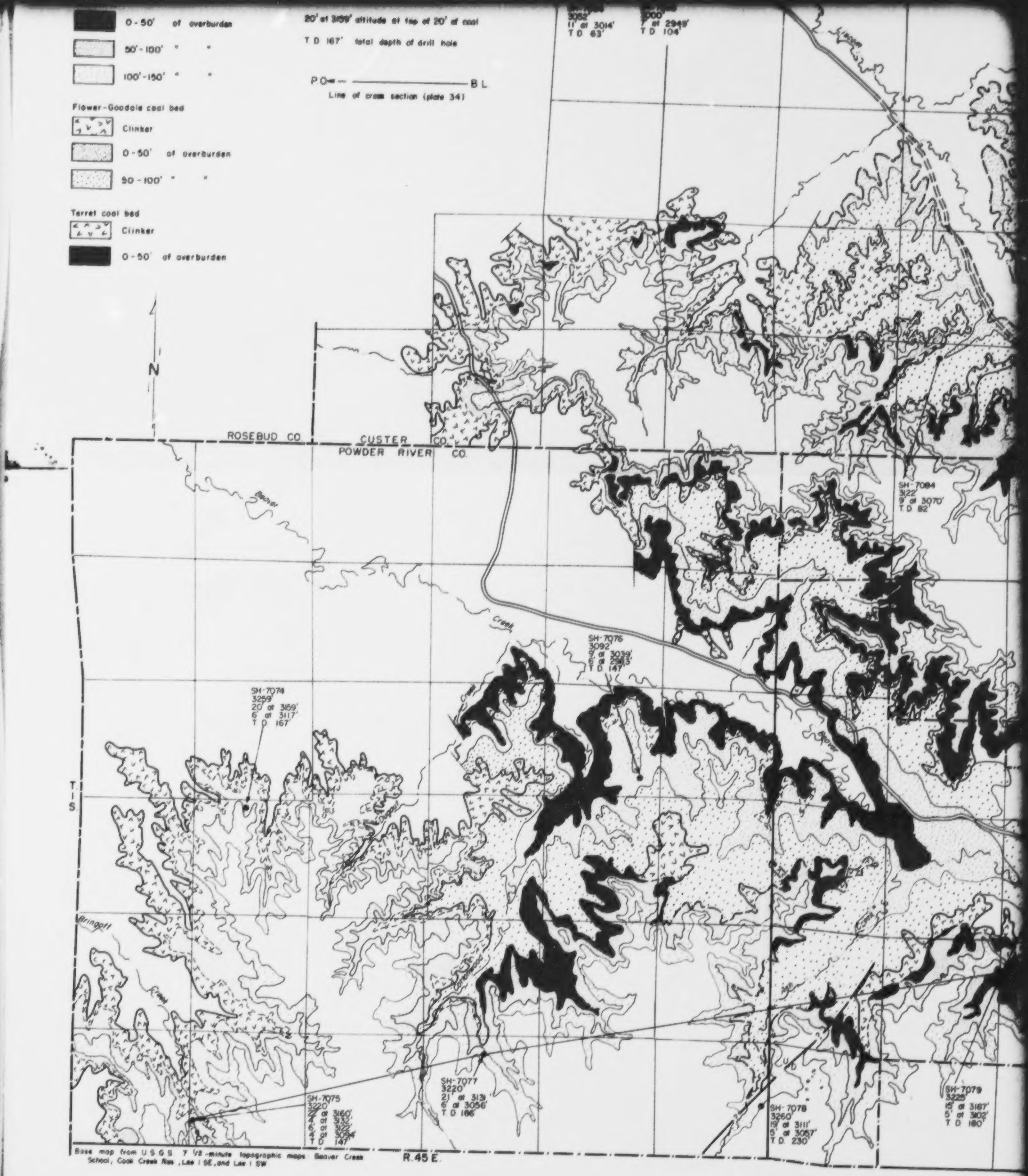

R.45 E.
Limit of topographic coverage
SH-7094
3052'
11' at 3014'
T D 63'
SH-7095
3000
7' at 2949'
T D 104'
Liscom
N
ROSEBUD CO.
CUSTER CO.
POWDER RIVER CO.
Beaver
Creek
SH-7084
3122
9' at 3070'
T D 82
SH-7076
3092
9' at 3039'
6' at 2983'
T D 147'
SH-7074
3259'
20' at 3159'
6' at 3117'
T D 167'
Creek
Beaver
T. 1 S.
Dugout
Bringoff
Creek

EOLOGY

COAL DEPOSIT

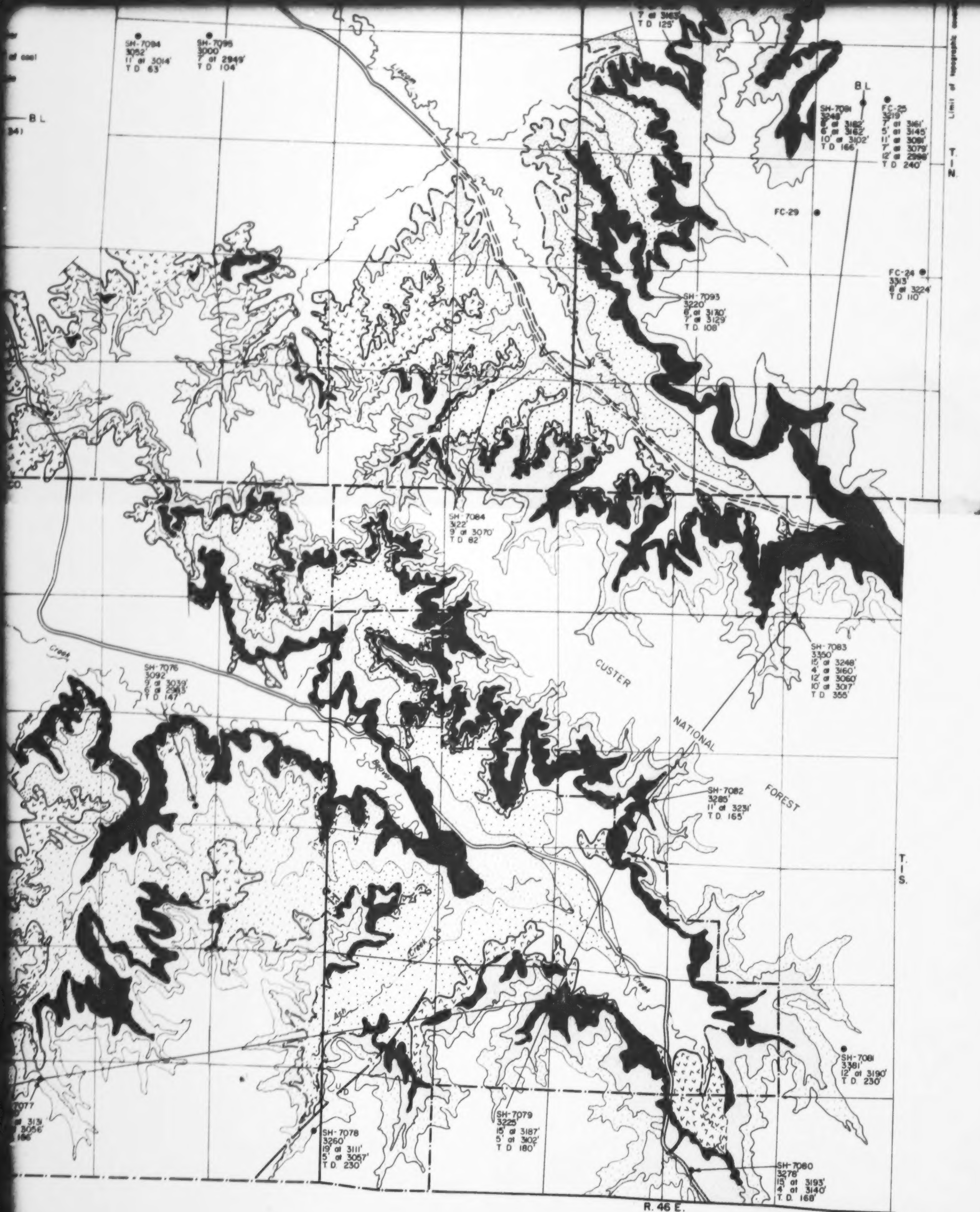
OODALE, AND KNOBLOCH
UNTIES, MONTANA


3 MILES
. drill hole
signation
at top of collar
at top of 20' of coal
pth of drill hole
B L
section (plate 34)
R.45 E.
Limit of topographic coverage
R.46 E.
Limit of topographic coverage
T. 1 N.
T. 1 S.
SH-7092
3255'
8' at 3190'
7' at 3163'
T.D. 125'
SH-7094
3052'
11' at 3014'
T.D. 63'
SH-7095
3000
7' at 2949'
T.D. 104'
SH-7091
3248'
8' at 3182'
6' at 3162'
10' at 3102'
T.D. 166'
B L
FC-25
3219
7' at 3161'
5' at 3145'
11' at 3091'
7' at 3079'
12' at 2998'
T.D. 240'
FC-29
FC-24
3313'
8' at 3224'
T.D. 110'
SH-7093
3220
8' at 3170'
7' at 3129'
T.D. 108'
Liscom
Creek
STER CO.
R RIVER CO.
SH-7084
3122'
9' at 3070'
T.D. 82'
SH-7083
3350'
15' at 3248'
4' at 3160'
12' at 3060'
10' at 3017'
T.D. 355'
CUSTER
NATIONAL
FOREST
SH-7076
3092'
9' at 3039'
6' at 2983'
T.D. 147'
Creek
Beaver
SH-7082
3285'
11' at 3231'
T.D. 165'
Creek
Creek


0 - 50' of overburden
50'-100' " "
100'-150' " "
Flower-Goodale coal bed
Clinker
0 - 50' of overburden
50 - 100' " "
Terret coal bed
Clinker
0 - 50' of overburden
20' at 3159' altitude at top of 20' of coal
T D 167' total depth of drill hole
P O — — B L
Line of cross section (plate 34)
3052
11' at 3014'
T D 63'
7' at 2948'
T D 104'
N
ROSEBUD CO.
CUSTER CO.
POWDER RIVER CO.
Beaver
Creek
SH-7084
3122'
9' at 3070'
T D 82'
SH-7076
3092
9' at 3039'
6' at 2983'
T D 147
SH-7074
3259'
20' at 3159'
6' at 3117'
T D 167'
T 1 S.
Dugout
Bringoff
Creek
Cottonwood
SH-7077
3220'
21' at 3131'
6' at 3056'
T D 186
SH-7075
3220'
22' at 3160'
4' at 3132'
6' at 3122'
4' at 3094'
T D 147
SH-7078
3260'
19' at 3111'
5' at 3057'
T D 230'
SH-7079
3225'
15' at 3187'
5' at 3102'
T D 180'
U
D
PO
R.45 E.

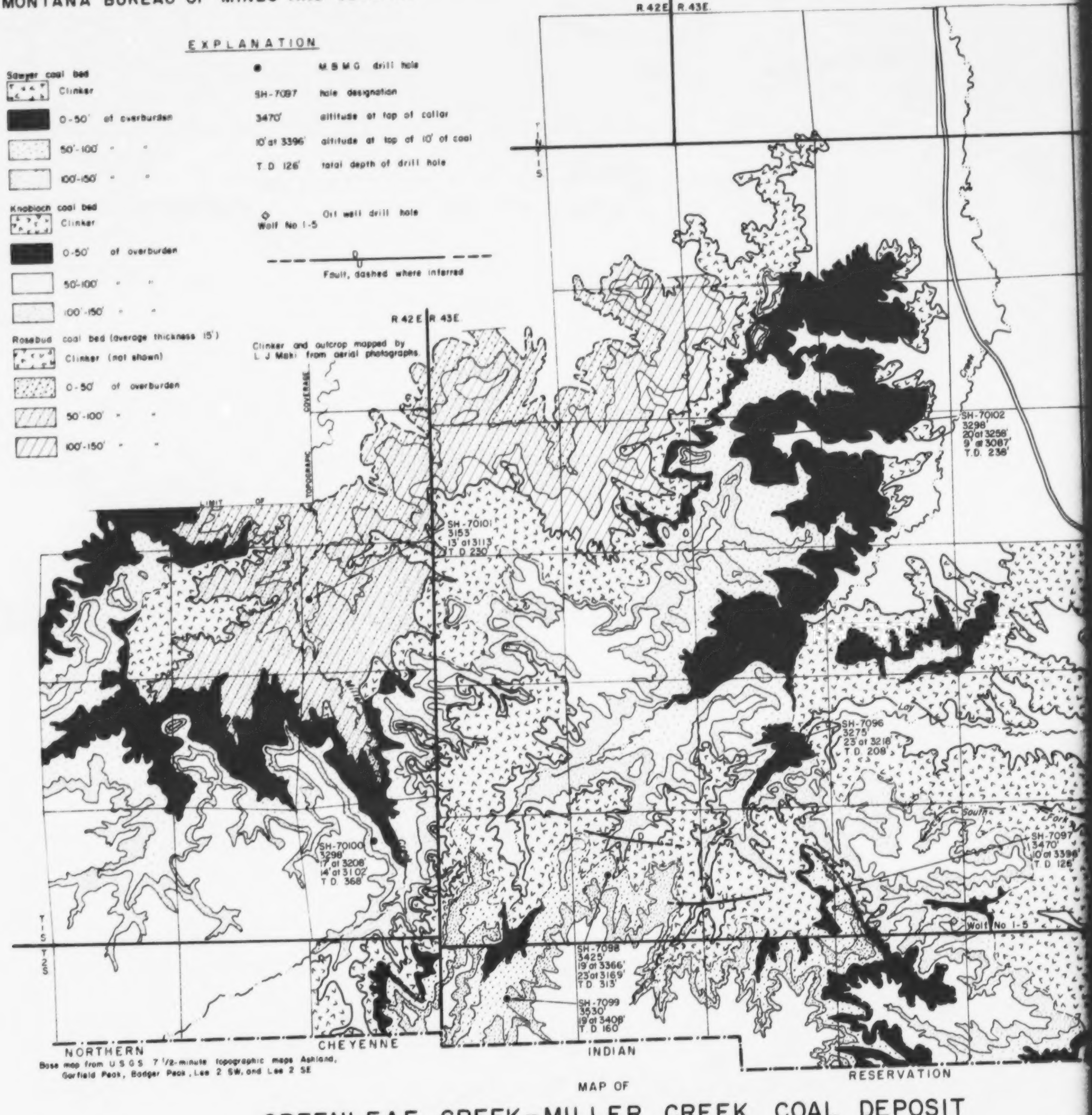
Base map from U.S.G.S. 7 1/2-minute topographic maps: Beaver Creek School, Cook Creek Res., Lee 1 SE, and Lee 1 SW

C


of coal
B L
341
SH-7094
3052'
11' at 3014'
T D 63'
SH-7095
3000'
7' at 2949'
T D 104'
7' at 3163'
T D 125'
B L
SH-7091
3248'
8' at 3182'
6' at 3162'
10' at 3102'
T D 166'
FC-25
3219'
7' at 3161'
5' at 3145'
11' at 3081'
7' at 3079'
12' at 2998'
T D 240'
Limit of topographic
T. 1 N.
FC-29
FC-24
3313'
8' at 3224'
T D 110'
SH-7093
3220'
6' at 3170'
7' at 3129'
T D 108'
Creek
CO.
SH-7084
3122'
9' at 3070'
T D 82'
Creek
SH-7076
3092'
9' at 3039'
6' at 2983'
T D 147'
CUSTER
NATIONAL
FOREST
SH-7083
3350'
15' at 3248'
4' at 3160'
12' at 3060'
10' at 3017'
T D 355'
SH-7082
3285'
11' at 3231'
T D 165'
T. 1 S.
Creek
Creek
Ash
U
D
7077
at 3131'
3056'
166'
SH-7078
3260'
19' at 3111'
5' at 3057'
T D. 230'
SH-7079
3225'
15' at 3187'
5' at 3102'
T D 180'
SH-7081
3381'
12' at 3190'
T D 230'
SH-7080
3278'
15' at 3193'
4' at 3140'
T. D. 168'
R. 46 E.

Project Chief -R. E. Matson
Geologists -M. L. Granberg
L. J. Maki
Draftsman -C. M. Blankenship

D


EXPLANATION
Sawyer coal bed
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
Knobloch coal bed
Clinker
0-50' of overburden
50'-100' " "
100'-150' " "
Rosebud coal bed (average thickness 15')
Clinker (not shown)
0-50' of overburden
50'-100' " "
100'-150' " "
M B M G drill hole
SH-7097 hole designation
3470' altitude at top of collar
10' at 3396' altitude at top of 10' of coal
T D 126' total depth of drill hole
Wolf No 1-5 Oil well drill hole
Fault, dashed where inferred
Clinker and outcrop mapped by L J Maki from aerial photographs.
R 42 E R 43 E
T 1 N
T 1 S
T 1 S
T 2 S
LIMIT OF TOPOGRAPHIC COVERAGE
SH-70102 3298' 20' at 3256' 9' at 3087' T.D. 236'
SH-70101 3153' 13' at 3113' T D 230'
SH-7096 3275' 23' at 3216' T D 208'
SH-7097 3470' 10' at 3396' T D 126'
SH-70100 3298' 17' at 3208' 14' at 3102' T D 368'
SH-7098 3425' 19' at 3366' 23' at 3169' T D 313'
SH-7099 3530' 19' at 3408' T D 160'
Wolf No 1-5
South Fork
NORTHERN CHEYENNE INDIAN RESERVATION

Base map from U S G S 7 1/2-minute topographic maps Ashland, Garfield Peak, Badger Peak, Lee 2 SW, and Lee 2 SE

MAP OF

GREENLEAF CREEK–MILLER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE SAWYER, KNOBLOCH, AND ROSEBUD COAL BEDS, ROSEBUD COUNTY, MONTANA

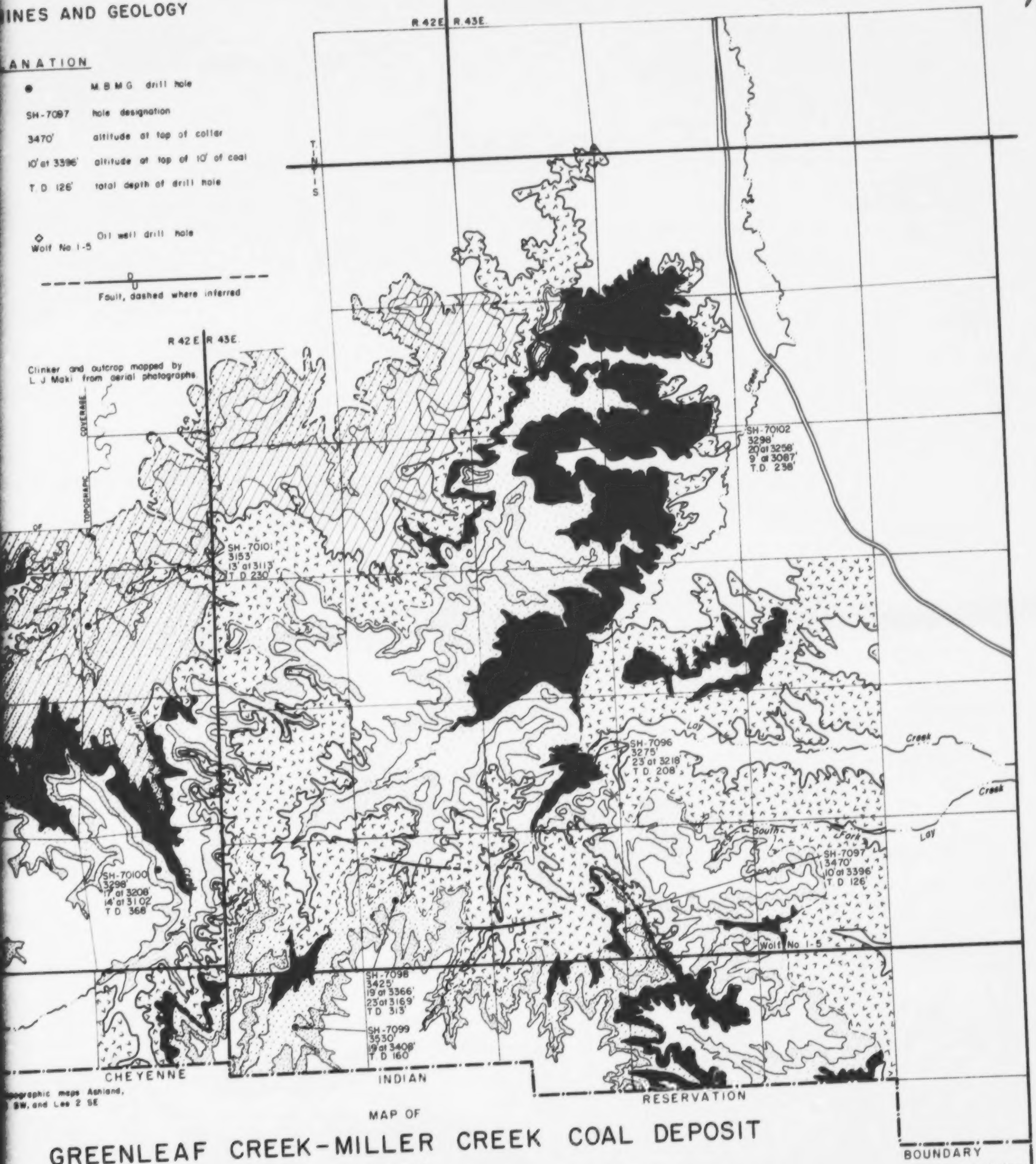
N

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

B


ANATION
●
M B M G drill hole
SH-7097 hole designation
3470' altitude at top of collar
10' at 3396' altitude at top of 10' of coal
T D 126' total depth of drill hole
◇ Wolf No 1-5 Oil well drill hole
Fault, dashed where inferred
R 42 E R 43E.
R 42 E R 43E.
T 1 N
T 1 S
Clinker and outcrop mapped by L. J. Maki from aerial photographs
COVERAGE
TOPOGRAPHIC
SH-70102 3298' 20' at 3258' 9' at 3087' T.D. 238'
SH-70101 3153' 13' at 3113' T D 230'
SH-7096 3275' 23' at 3218' T D 208'
SH-7097 3470' 10' at 3396' T D 126'
SH-70100 3298' 17' at 3208' 14' at 3102' T D 368
SH-7098 3425' 19 at 3366' 23' at 3169' T D 313'
SH-7099 3530' 19 at 3408' T D 160
Wolf No 1-5
Creek
Lay
Creek
Creek
Lay
South
Fork
pographic maps Ashland,
SW, and Lee 2 SE
CHEYENNE
INDIAN
RESERVATION
BOUNDARY

Project Chief - R E Matson
Geologist - L. J. Maki
Draftsman - E A Woods

MAP OF

GREENLEAF CREEK-MILLER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE SAWYER, KNOBLOCH, AND ROSEBUD COAL BEDS, ROSEBUD COUNTY, MONTANA

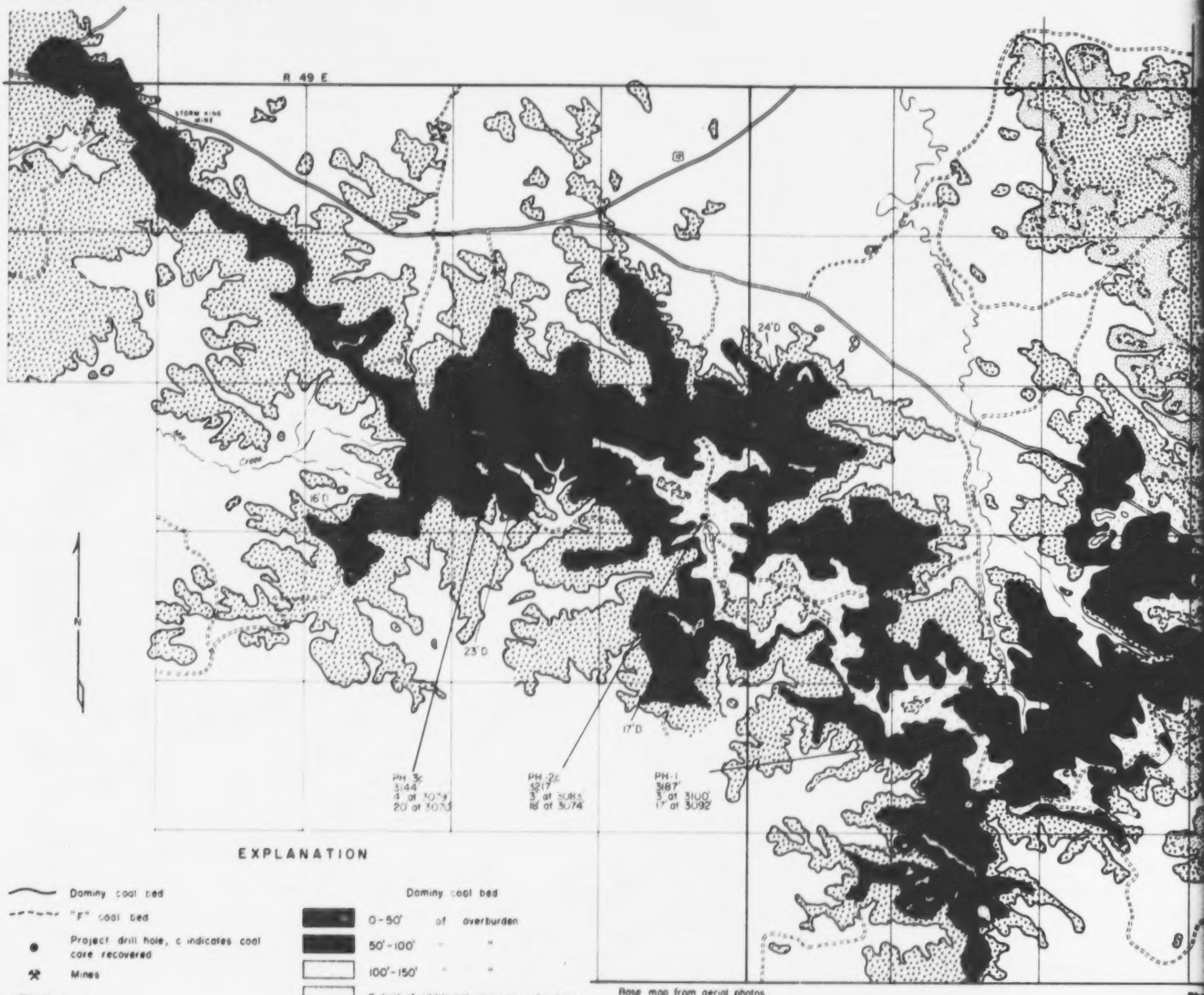
SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

MONTANA BUREAU OF MINES AND GEOLOGY

A


R 49 E
STORM KING MINE
Creek
24'D
16'D
23'D
17'D
PH-3c
3144'
4' at 3079'
20' at 3073
PH-2c
3217'
3' at 3083
18' at 3074
PH-1
3187'
3' at 3100'
17' at 3092
N

Base map from aerial photos

EXPLANATION

~	Dominy coal bed
- - -	"F" coal bed
●	Project drill hole, c indicates coal core recovered
⚒	Mines
▨	Clinker
■16'D	USGS auger hole

Dominy coal bed

■	0-50' of overburden
■	50'-100' " "
☐	100'-150' " "
☐	Extent of additional reserves under less than 150' (approx.) overburden

SCALE

0 1/2 1 2 Miles

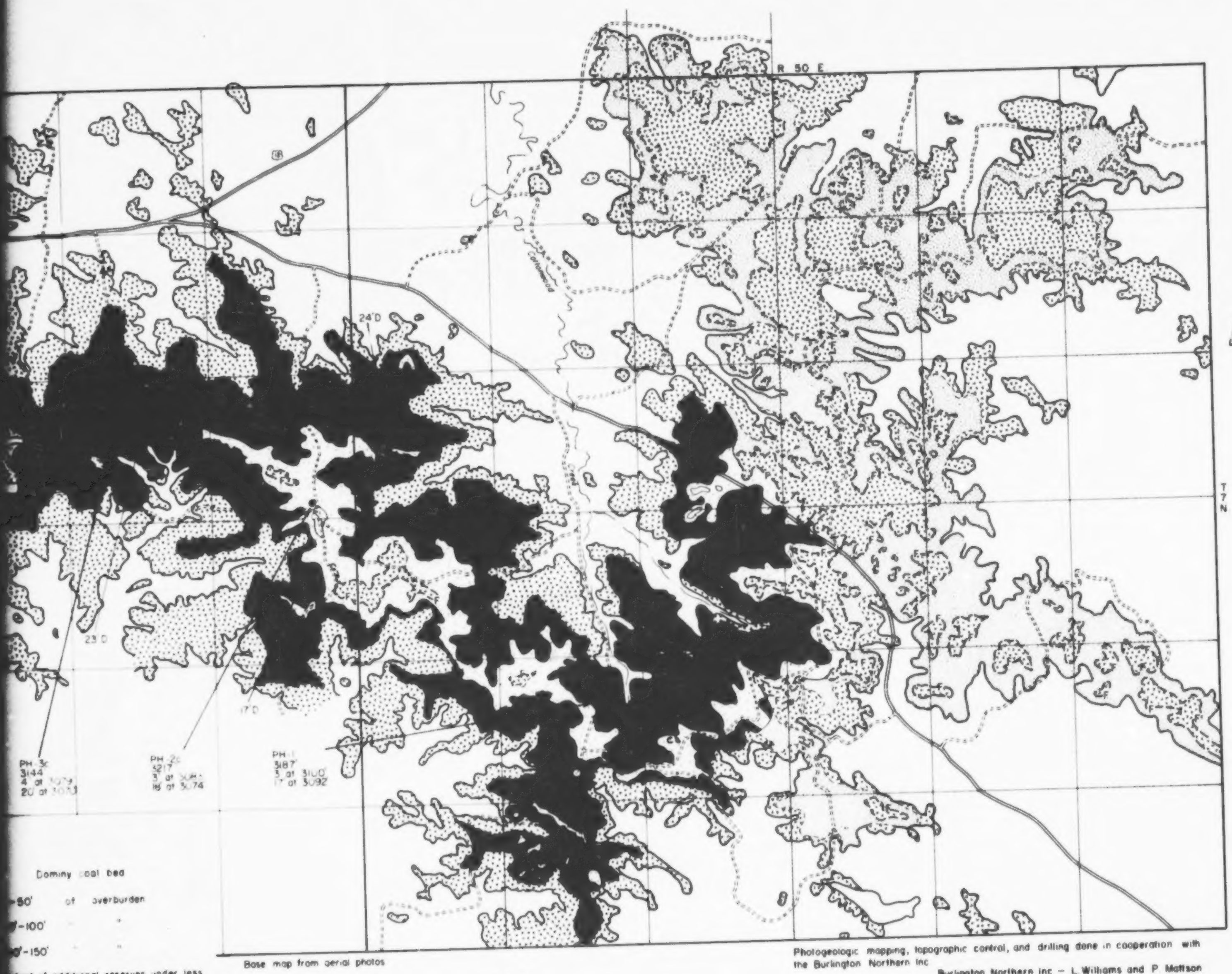
DATUM IS MEAN SEA LEVEL

MAP OF

PINE HILLS COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE DOMINY COAL BED, CUSTER COUNTY, MONTANA


R 50 E
T 7 N
24'D
23'D
17'D
PH-3c
3144
4 at 3079
20 at 3073
PH-2c
3217
3 at 3084
18 at 3074
PH-1
3187
3 at 3100
17 at 3092

Base map from aerial photos

Dominy coal bed

-50' of overburden

-100' " "

-150' " "

ent of additional reserves under less
150' (approx) overburden

2 Miles

Photogeologic mapping, topographic control, and drilling done in cooperation with the Burlington Northern Inc

Burlington Northern inc — L. Williams and P. Mattson
Montana Bureau of Mines and Geology — R E Matson and G Dahl
Draftsman — M. J Daniels

MAP OF

PINE HILLS COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE DOMINY COAL BED, CUSTER COUNTY, MONTANA

A

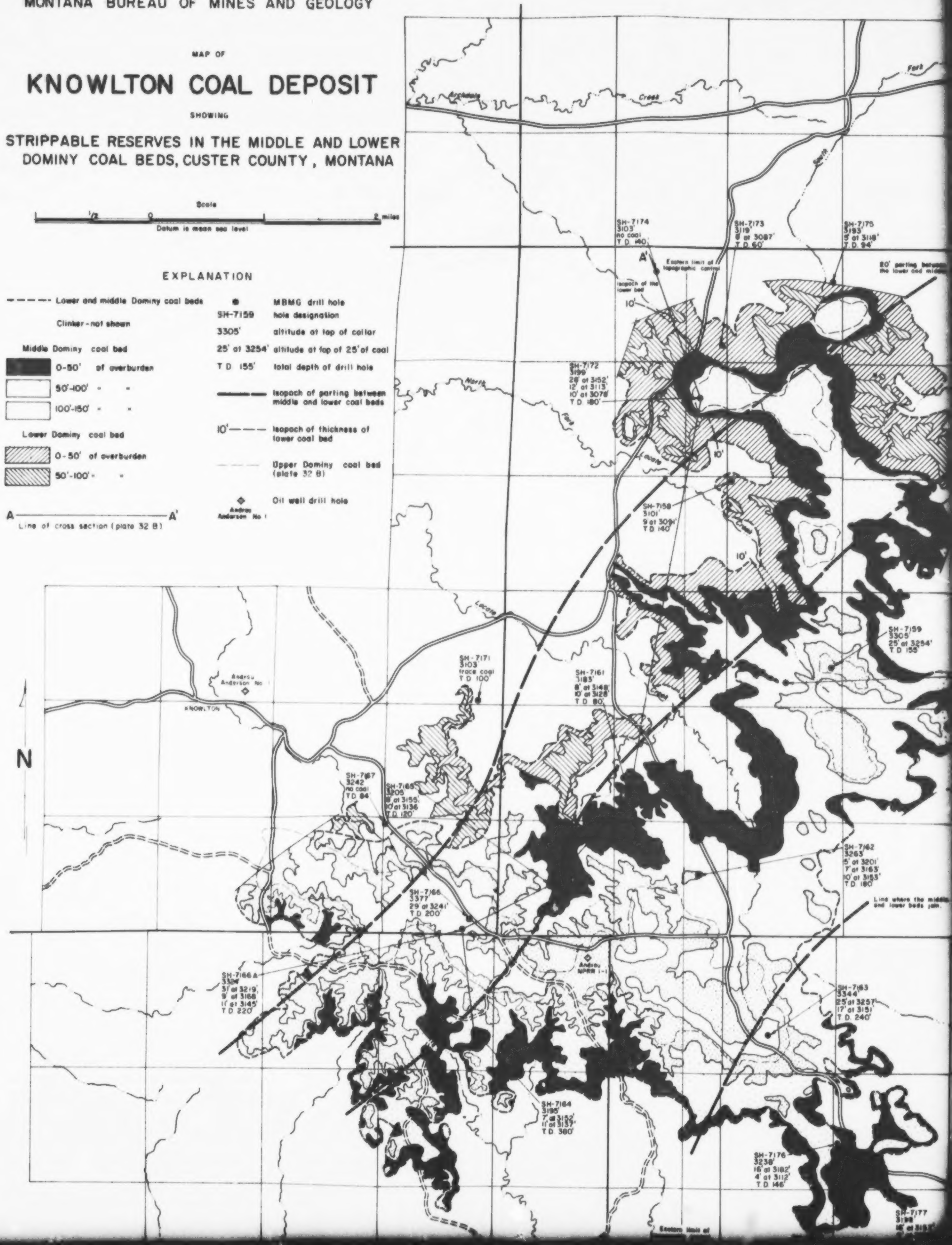
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

KNOWLTON COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE MIDDLE AND LOWER DOMINY COAL BEDS, CUSTER COUNTY, MONTANA


Scale
1/2
0
2 miles
Datum is mean sea level
EXPLANATION
Lower and middle Dominy coal beds
Clinker - not shown
Middle Dominy coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
Lower Dominy coal bed
0-50' of overburden
50'-100' " "
A — A'
Line of cross section (plate 32 B)
MBMG drill hole
SH-7159 hole designation
3305' altitude at top of collar
25' at 3254' altitude at top of 25' of coal
T D 155' total depth of drill hole
Isopach of parting between middle and lower coal beds
10' Isopach of thickness of lower coal bed
Upper Dominy coal bed (plate 32 B)
Oil well drill hole
Andrau Anderson No 1
Archdale
Creek
Fort
South
SH-7174
3103'
no coal
T D 140'
SH-7173
3119'
6' at 3087'
T D 60'
SH-7175
3193'
5' at 3118'
T D 94'
A'
Eastern limit of topographic control
Isopach of the lower bed
10'
20' parting between the lower and middle
SH-7172
3199'
28' at 3152'
12' at 3113'
10' at 3078'
T D 180'
North
Fork
Locate
10'
SH-7158
3101'
9' at 3091'
T D 140'
10'
Locate
SH-7159
3305'
25' at 3254'
T D 155'
SH-7171
3103'
trace coal
T D 100'
SH-7161
3183'
8' at 3148'
10' at 3128'
T D 80'
Andrau Anderson No 1
KNOWLTON
N
SH-7167
3242'
no coal
T D 84'
SH-7165
3205'
8' at 3155'
10' at 3136'
T D 120'
SH-7162
3263'
5' at 3201'
7' at 3163'
10' at 3153'
T D 180'
SH-7166
3377'
29' at 3241'
T D 200'
Line where the middle and lower beds join.
SH-7166 A
3324'
31' at 3219'
9' at 3168'
11' at 3145'
T D 220'
Andrau NPRR 1-1
SH-7163
3344'
25' at 3257'
17' at 3151'
T D 240'
SH-7164
3195'
7' at 3152'
11' at 3137'
T D 380'
SH-7176
3238'
16' at 3182'
4' at 3112'
T D 146'
SH-7177
Eastern limit of

EOLOGY

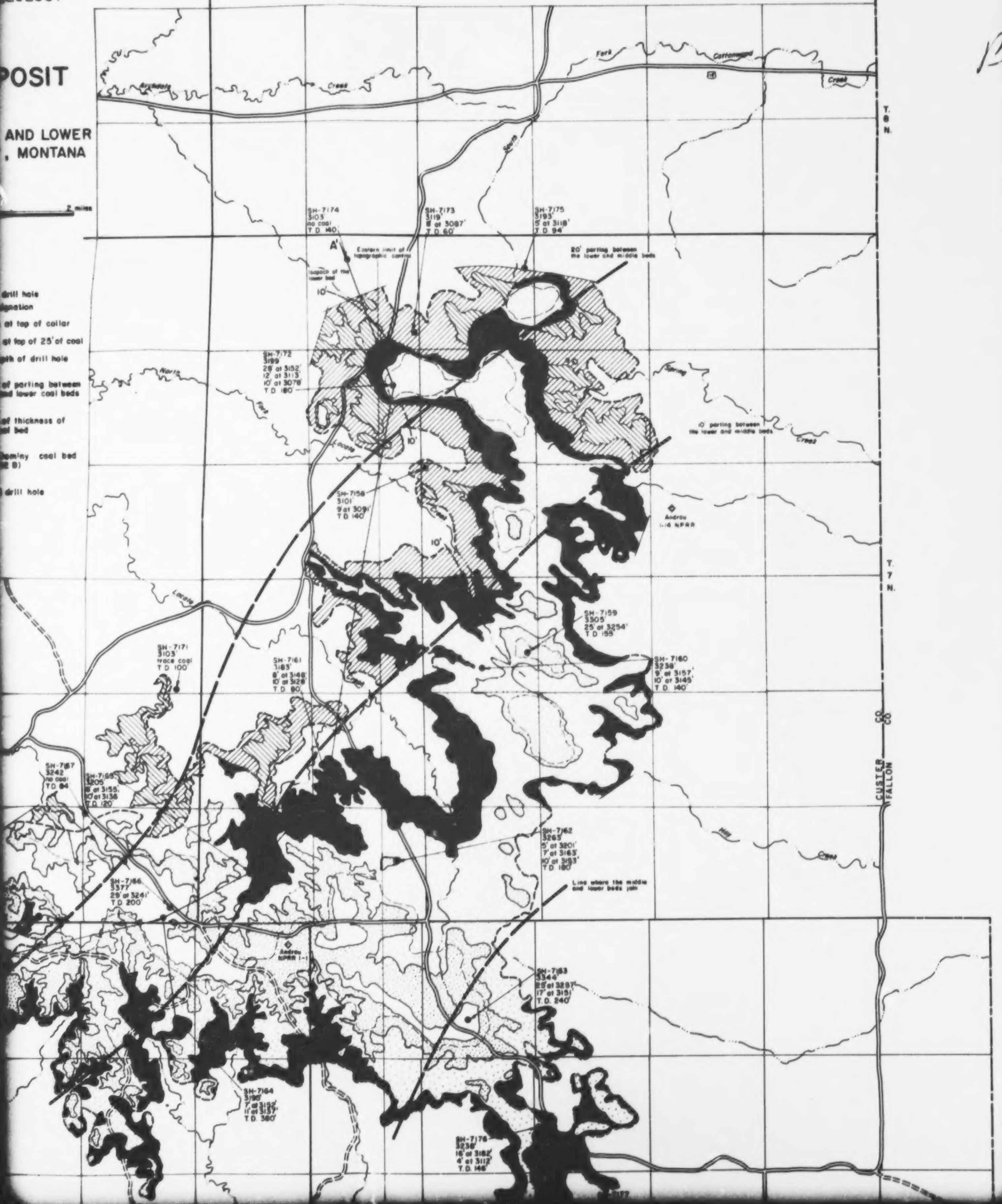
BULLETIN 91 PLATE 32 A

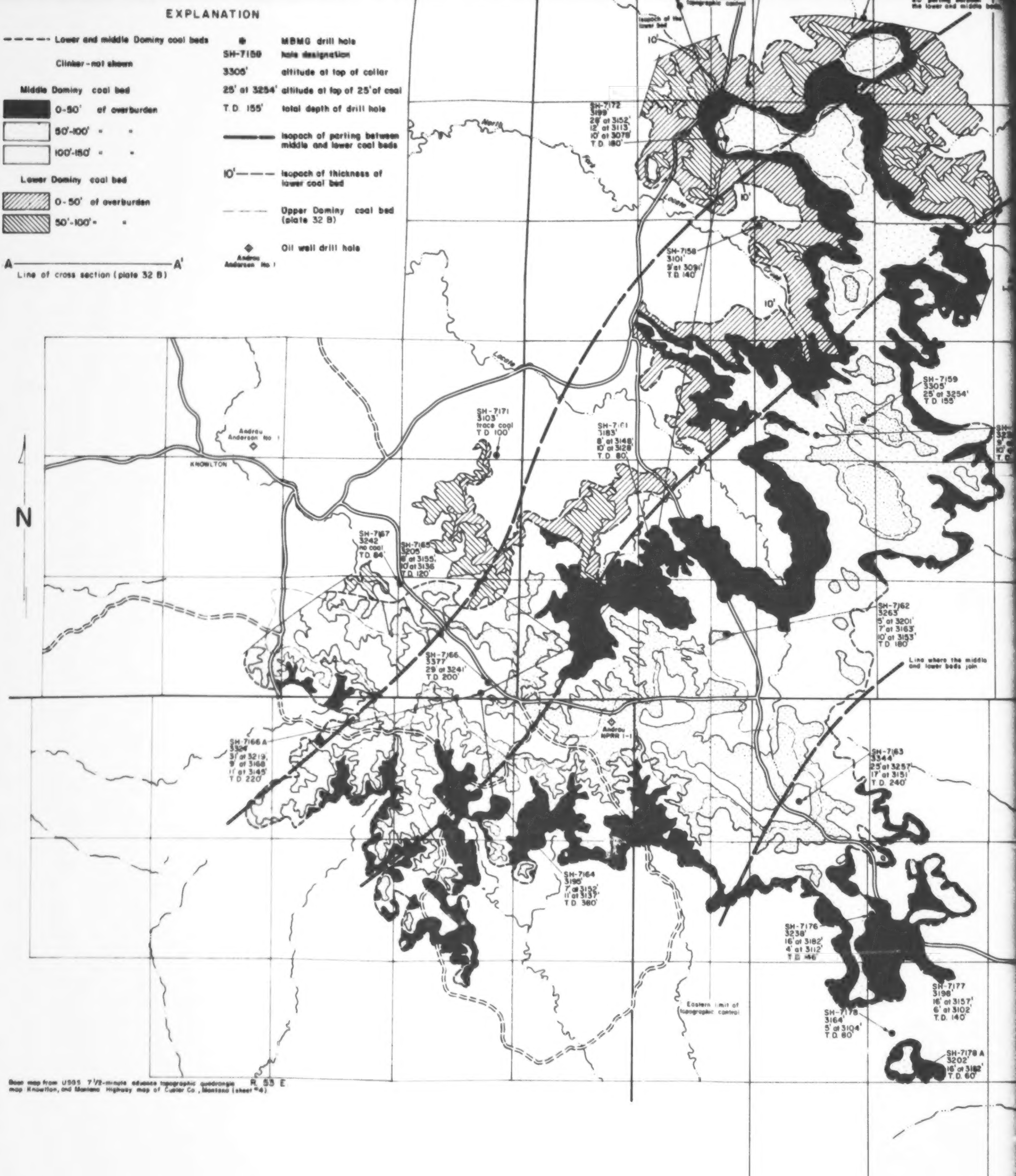
POSIT

AND LOWER
, MONTANA

2 miles

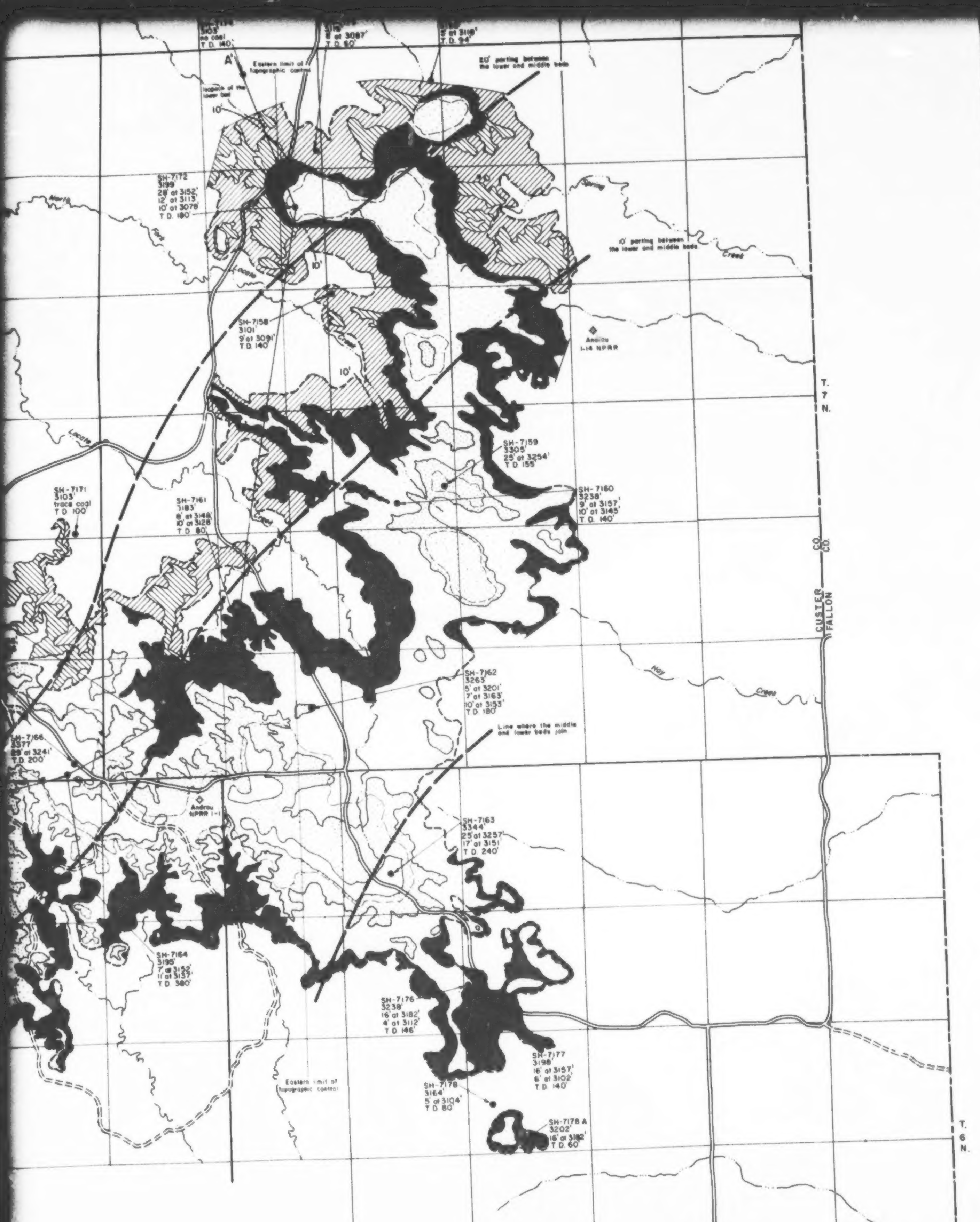
drill hole
ignation
at top of collar
at top of 25' of coal
pth of drill hole
of parting between
and lower coal beds
of thickness of
al bed
Dominy coal bed
2 B)
drill hole


Fork
Cottonwood
Creek
Creek
Creek
T. 8 N.
T. 7 N.
CUSTER
FALLON
Sevrin
North
Fork
Locate
Spring
Creek
Creek
Hay
Creek
SH-7174
3103'
no coal
T D 140'
SH-7173
3119'
8' at 3087'
T D 60'
SH-7175
3193'
5' at 3118'
T D 94'
A'
Eastern limit of topographic control
Isopach of the lower bed
10'
20' parting between the lower and middle beds
SH-7172
3199
28' at 3152'
12' at 3113'
10' at 3078'
T D 180'
10'
10' parting between the lower and middle beds
SH-7158
3101'
9' at 3091'
T D 140'
Andrau
1-14 NPRR
10'
SH-7159
3305'
25' at 3254'
T D 155'
SH-7160
3238'
9' at 3157'
10' at 3149'
T D 140'
SH-7171
3103'
trace coal
T D 100'
SH-7161
3183'
8' at 3148'
10' at 3128'
T D 80'
SH-7167
3242
no coal
T D 84
SH-7165
3205
8' at 3155'
10' at 3136
T D 120
SH-7162
3265'
5' at 3201'
7' at 3163'
10' at 3153'
T D 180'
Line where the middle and lower beds join
SH-7166
3377'
29' at 3241'
T D 200'
Andrau
NPRR 1-1
SH-7163
3344'
25' at 3287'
17' at 3151'
T.D. 240'
SH-7164
3195'
7' at 3152'
11' at 3137'
T.D. 380'
SH-7176
3238'
16' at 3182'
4' at 3112'
T.D. 146'


EXPLANATION
Lower and middle Dominy coal beds
Clinker - not shown
Middle Dominy coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
Lower Dominy coal bed
0-50' of overburden
50'-100' " "
A — A' Line of cross section (plate 32 B)
MBMG drill hole
SH-7159 hole designation
3305' altitude at top of collar
25' at 3254' altitude at top of 25' of coal
T.D. 155' total depth of drill hole
Isopach of parting between middle and lower coal beds
10' Isopach of thickness of lower coal bed
Upper Dominy coal bed (plate 32 B)
Oil well drill hole
Andrau Anderson No. 1
A'
Eastern limit of topographic control
Isopach of the lower bed
10'
20' parting between the lower and middle beds
SH-7172
3199'
28' at 3152'
12' at 3113'
10' at 3078'
T.D. 180'
North Fork
Locate
SH-7158
3101'
5' at 3091'
T.D. 140'
SH-7159
3305'
25' at 3254'
T.D. 155'
Locate
Andrau Anderson No. 1
KNOWLTON
N
SH-7171
3103'
trace coal
T.D. 100'
SH-7161
3183'
8' at 3148'
10' at 3128'
T.D. 80'
SH-7167
3242'
no coal
T.D. 84'
SH-7165
3205'
8' at 3155'
10' at 3136'
T.D. 120'
SH-7162
3263'
5' at 3201'
7' at 3163'
10' at 3153'
T.D. 180'
SH-7166
3377'
29 at 3241'
T.D. 200'
Line where the middle and lower beds join
Andrau NPRW 1-1
SH-7166 A
3324'
31' at 3219'
9' at 3168'
11' at 3145'
T.D. 220'
SH-7163
3344'
25' at 3257'
17' at 3151'
T.D. 240'
SH-7164
3195'
7' at 3152'
11' at 3137'
T.D. 380'
SH-7176
3238'
16' at 3182'
4' at 3112'
T.D. 146'
Eastern limit of topographic control
SH-7177
3198'
16' at 3157'
6' at 3102'
T.D. 140'
SH-7178
3164'
5' at 3104'
T.D. 60'
SH-7178 A
3202'
16' at 3182'
T.D. 60'
R. 53 E
R. 54 E.

Base map from USGS 7 1/2-minute advance topographic quadrangle map Knowlton, and Montana Highway map of Custer Co., Montana (sheet #4)

C


3103'
no coal
T.D. 140'
3115'
8' at 3087'
T.D. 60'
5' at 3118'
T.D. 94'
A'
Eastern limit of topographic control
Isopach of the lower bed
10'
20' parting between the lower and middle beds
SH-7172
3199'
28' at 3152'
12' at 3113'
10' at 3078'
T.D. 180'
Spring
Fort
Locate
10'
10' parting between the lower and middle beds
Creek
SH-7158
3101'
9' at 3091'
T.D. 140'
Creek
10'
Anadarko
1-14 NPRR
T.
7
N.
Locate
SH-7159
3305'
25' at 3254'
T.D. 155'
SH-7160
3238'
9' at 3157'
10' at 3145'
T.D. 140'
SH-7171
3103'
trace coal
T.D. 100'
SH-7161
3183'
8' at 3148'
10' at 3128'
T.D. 80'
Creek
CUSTER CO.
FALLON
Hay
Creek
SH-7162
3263'
5' at 3201'
7' at 3163'
10' at 3153'
T.D. 180'
Line where the middle and lower beds join
SH-7166
3377'
29' at 3241'
T.D. 200'
Andrau
NPRR 1-1
SH-7163
3344'
25' at 3257'
17' at 3151'
T.D. 240'
SH-7164
3195'
7' at 3152'
11' at 3137'
T.D. 380'
SH-7176
3238'
16' at 3182'
4' at 3112'
T.D. 146'
SH-7177
3198'
16' at 3157'
6' at 3102'
T.D. 140'
Eastern limit of topographic control
SH-7178
3164'
5' at 3104'
T.D. 80'
SH-7178 A
3202'
16' at 3182'
T.D. 60'
T.
6
N.
R. 54 E.

Project Chief	R. E. Matson
Geologist	J. W. Blumer
Draftsman	E. A. Woods

A

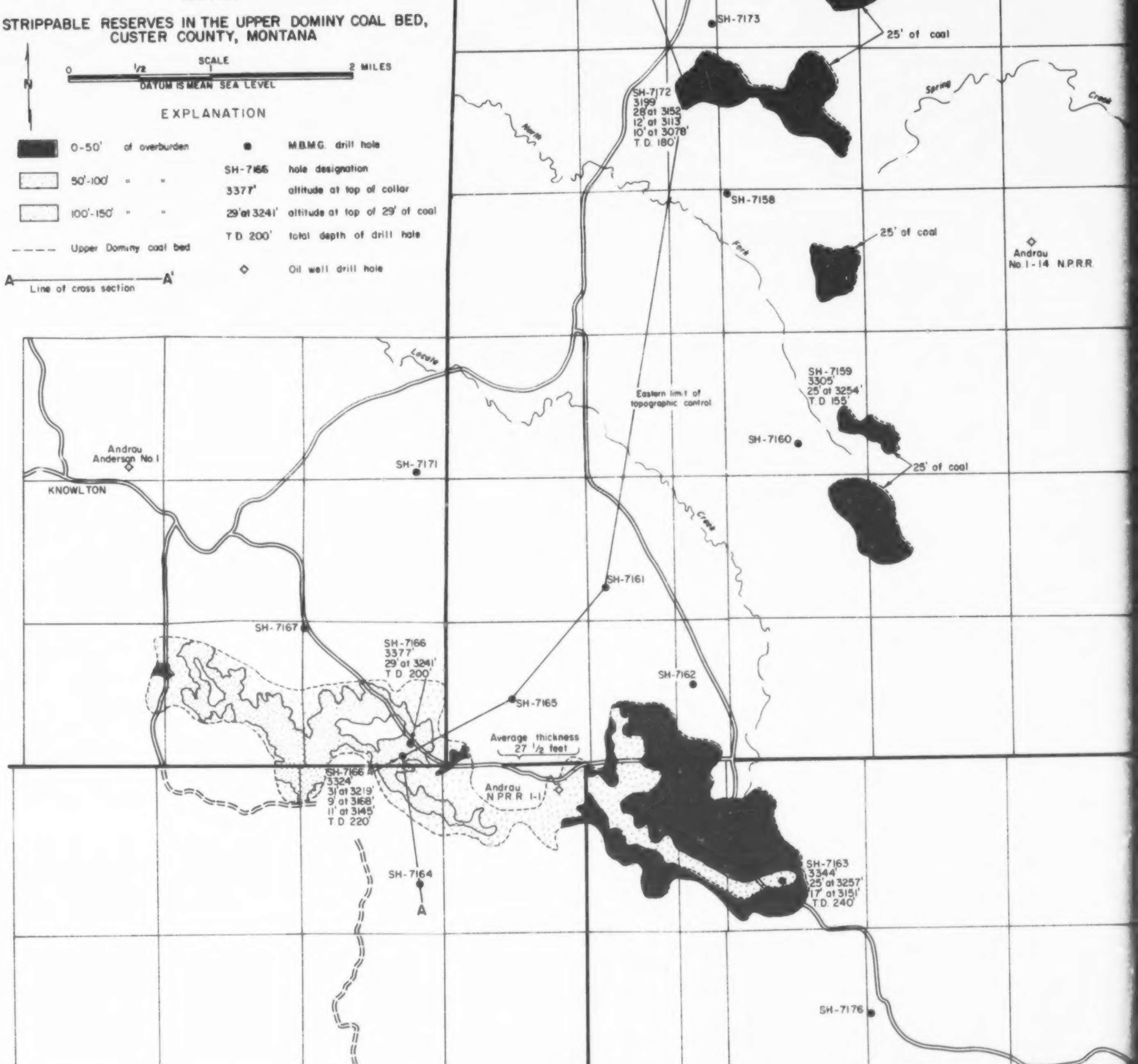
MONTANA BUREAU OF MINES AND GEOLOGY

MAP OF

KNOWLTON COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE UPPER DOMINY COAL BED, CUSTER COUNTY, MONTANA


N
SCALE
0
1/2
1
2 MILES
DATUM IS MEAN SEA LEVEL
EXPLANATION
0-50' of overburden
50'-100' " "
100'-150' " "
Upper Dominy coal bed
A — A'
Line of cross section
M.B.M.G. drill hole
SH-7166 hole designation
3377' altitude at top of collar
29' at 3241' altitude at top of 29' of coal
T.D. 200' total depth of drill hole
Oil well drill hole
A'
SH-7174
SH-7175
SH-7173
25' of coal
SH-7172
3199'
28' at 3152'
12' at 3113'
10' at 3078'
T.D. 180'
North
Fork
Creek
Spring
Creek
SH-7158
25' of coal
Andrau
No. 1-14 N.P.R.R.
Locate
Eastern limit of topographic control
SH-7159
3305'
25' at 3254'
T.D. 155'
SH-7160
25' of coal
Andrau
Anderson No. 1
KNOWLTON
SH-7171
SH-7161
SH-7167
SH-7166
3377'
29' at 3241'
T.D. 200'
SH-7165
SH-7162
Average thickness
27 1/2 feet
Andrau
N.P.R.R. 1-1
SH-7166 A
3324'
31' at 3219'
9' at 3168'
11' at 3145'
T.D. 220'
SH-7163
3344'
25' at 3257'
17' at 3151'
T.D. 240'
SH-7164
A
SH-7176
R 53 E.
R 54 E.

Base map from U.S.G.S. 7 1/2-minute advance topographic map Knowlton, and Montana Highway map of Custer Co., Montana (Sheet 14)

Project Chief - R.E.
Geologist - J.W.
Draftsman - E.A.

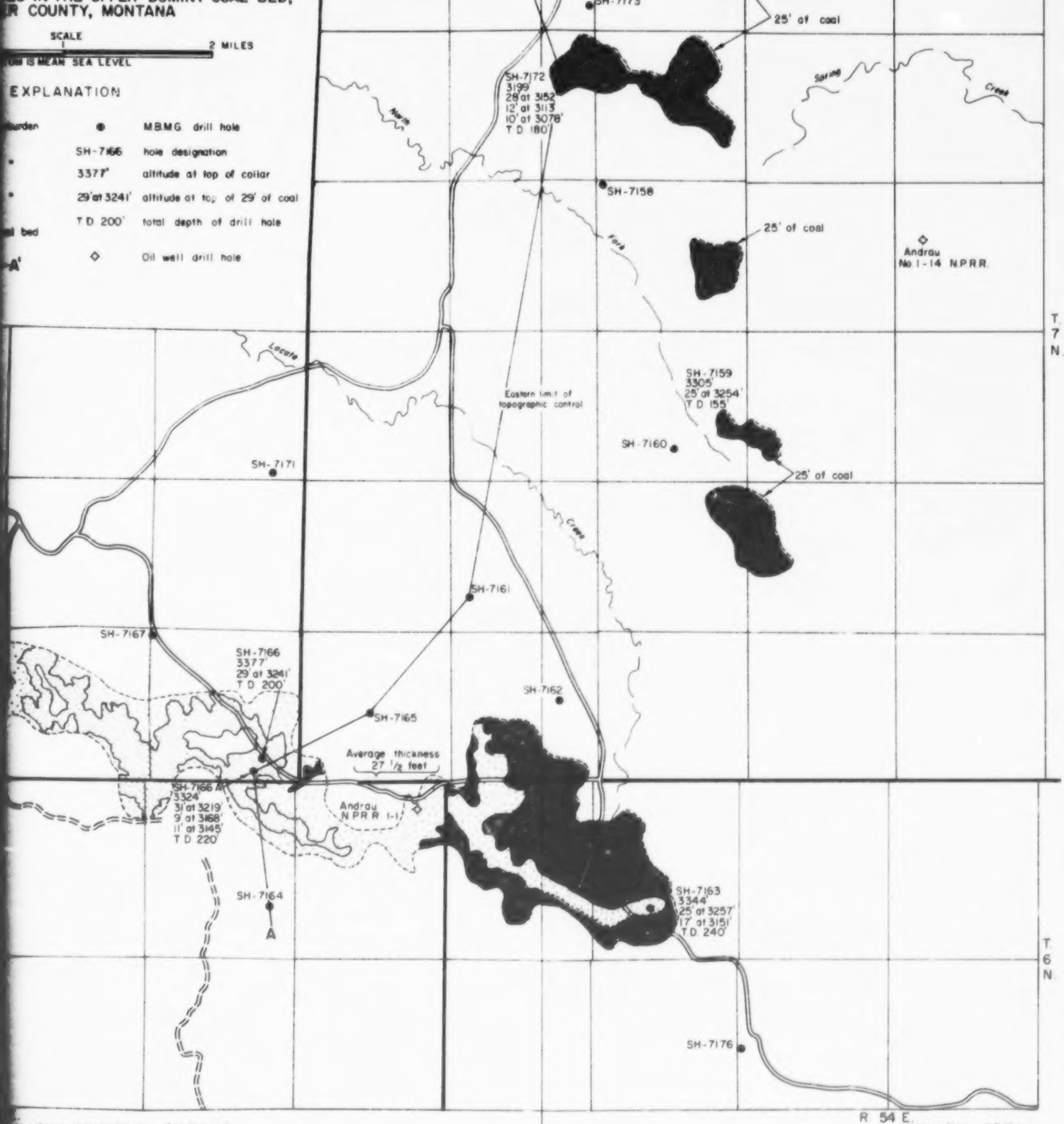
B

MAP OF

LTON COAL DEPOSIT

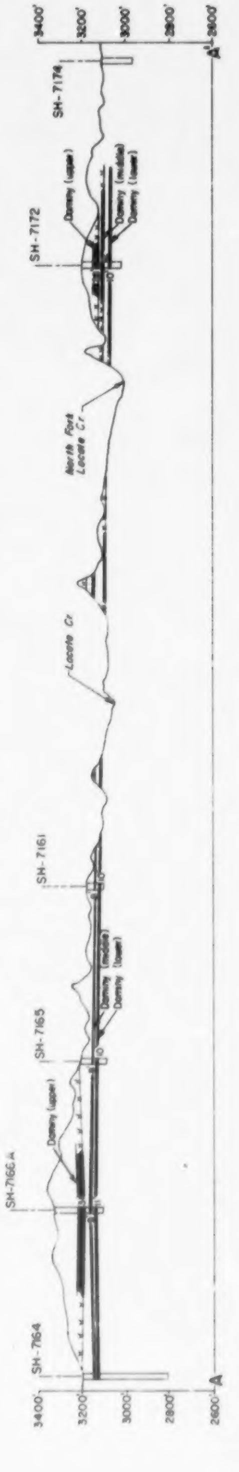
SHOWING

ES IN THE UPPER DOMINY COAL BED,
R COUNTY, MONTANA


SCALE
1
2 MILES
UM IS MEAN SEA LEVEL
EXPLANATION
urden
● MBMG drill hole
SH-7166 hole designation
3377' altitude at top of collar
29' at 3241' altitude at top of 29' of coal
TD 200' total depth of drill hole
l bed
◇ Oil well drill hole
A'
A'
SH-7174
SH-7175
SH-7173
25' of coal
SH-7172
3199'
28' at 3152'
12' at 3113'
10' at 3078'
T D 180'
North
Spring
Creek
SH-7158
Fork
25' of coal
Andrau
No. 1-14 N.P.R.R.
T.
7
N.
Locate
Eastern limit of topographic control
SH-7159
3305'
25' at 3254'
T D 155'
SH-7160
25' of coal
SH-7171
Creek
SH-7161
SH-7167
SH-7166
3377'
29' at 3241'
T D 200'
SH-7165
SH-7162
Average thickness 27 1/2 feet
SH-7166 A
3324'
31' at 3219'
9' at 3168'
11' at 3145'
T D 220'
Andrau
N.P.R.R. 1-1
SH-7164
A
SH-7163
3344'
25' at 3257'
17' at 3151'
T D 240'
T.
6
N.
SH-7176
R 54 E.

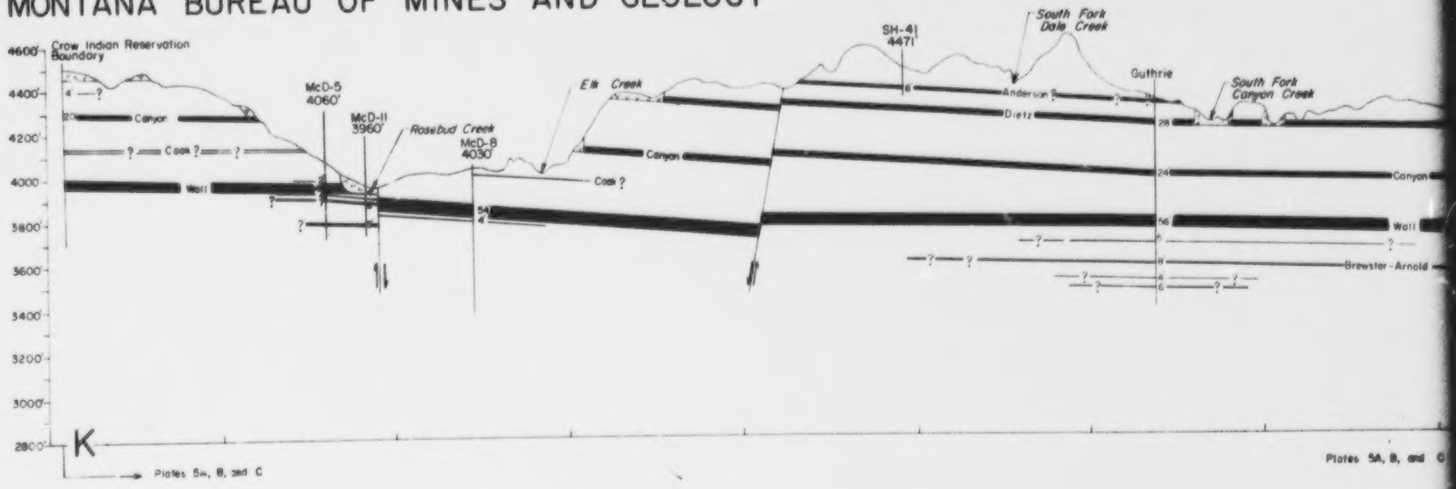
advance topographic map Knowlton, and
Co., Montana (Sheet 84)

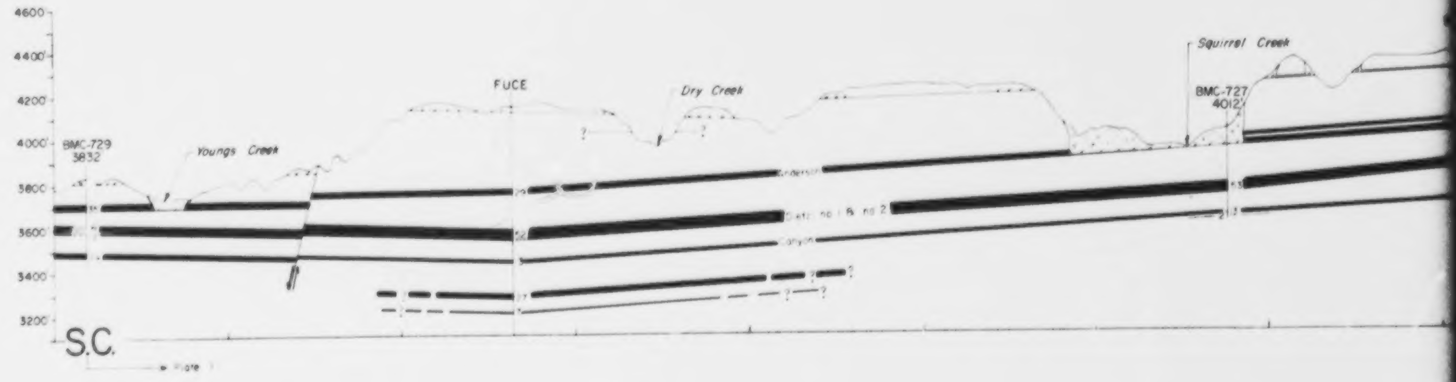
Project Chief - R.E. Matson
Geologist - J.W. Blumer
Draftsman - E.A. Woods

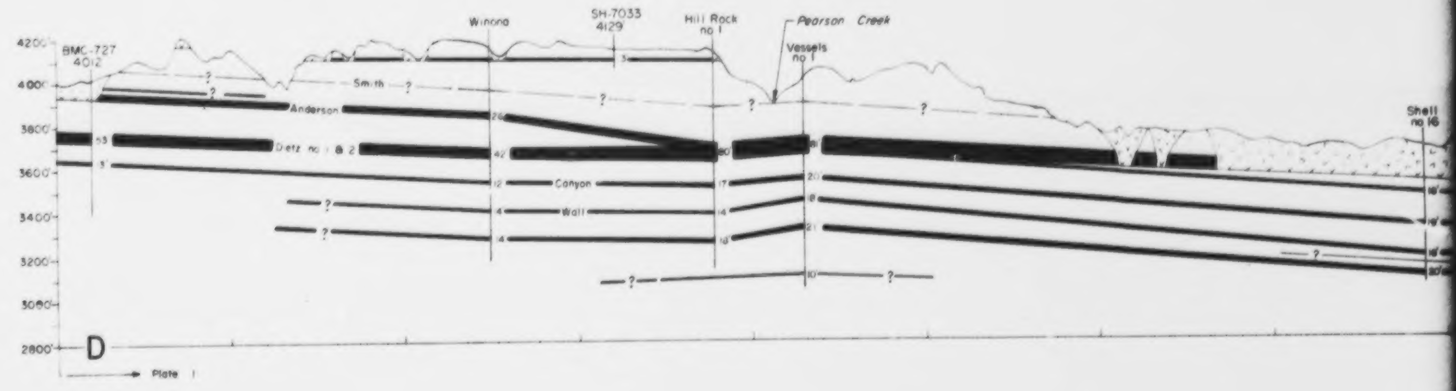

3400'
3200'
3000'
2800'
2600'
A'
SH-7174
Dominy (upper)
Dominy (middle)
Dominy (lower)
SH-7172
North Fork Locate Cr.
Locate Cr.
SH-7161
Dominy (middle)
Dominy (lower)
SH-7165
Dominy (upper)
SH-7166 A
SH-7164
3400'
3200'
3000'
2800'
2600'
A

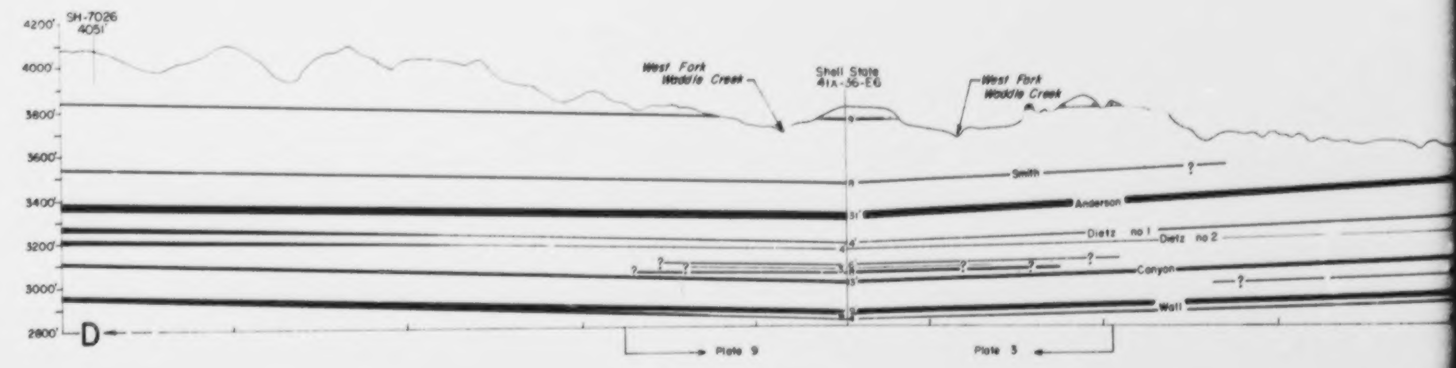
A

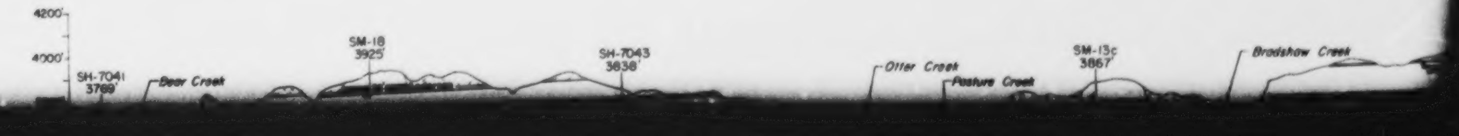
MONTANA BUREAU OF MINES AND GEOLOGY


K
Crow Indian Reservation Boundary
McD-5 4060'
McD-11 3960'
Rosebud Creek
McD-8 4030'
Elk Creek
SH-41 4471'
South Fork Dale Creek
Guthrie
South Fork Canyon Creek
Canyon
Cook ?
Wall
Anderson ?
Dietz
Brewster - Arnold
Plates 5A, B, and C
4600'
4400'
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'

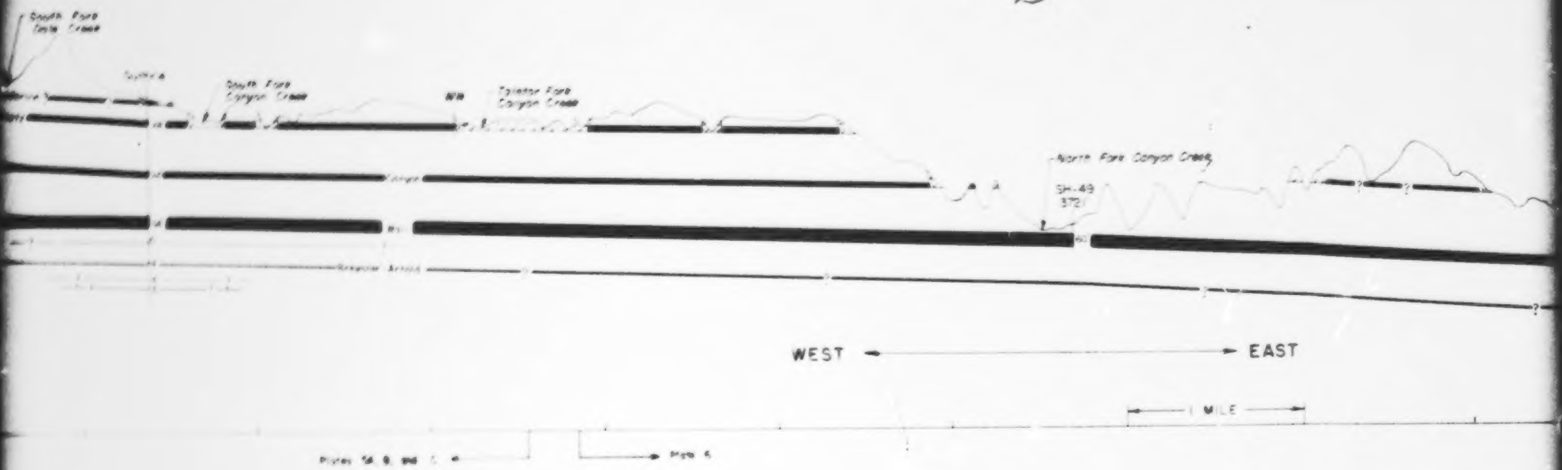

S.C.
BMC-729 3832
Youngs Creek
FUCE
Dry Creek
Squirrel Creek
BMC-727 4012'
Anderson
Dietz no 1 & no 2
Canyon
Plate 1
4600
4400
4200
4000
3800
3600
3400
3200

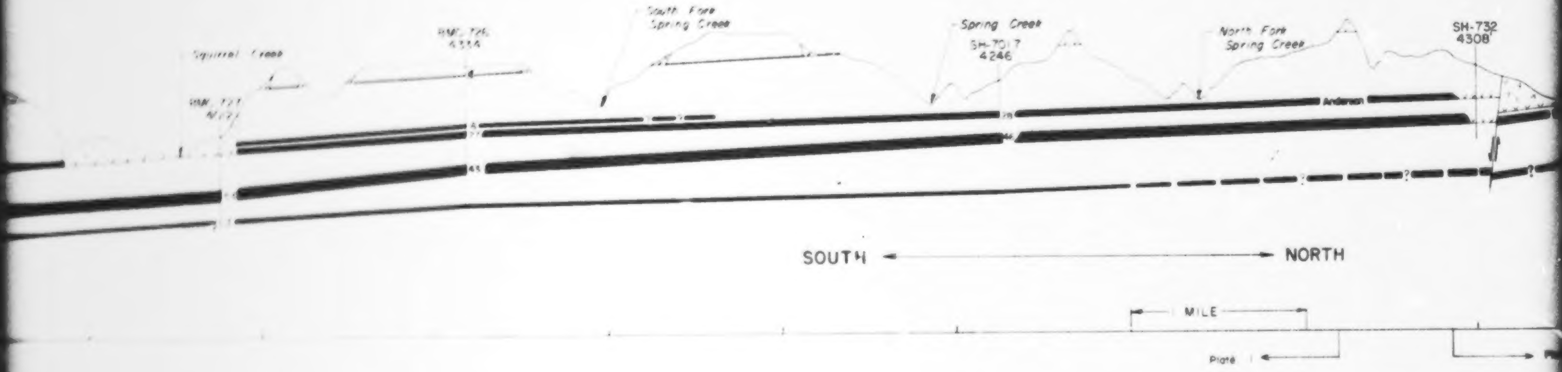

D
BMC-727 4012
Winona
SH-7033 4129
Hill Rock no 1
Pearson Creek
Vessels no 1
Shell no 16
Smith
Anderson
Dietz no 1 & 2
Canyon
Wall
Plate 1
4200
4000
3800
3600
3400
3200
3000
2800

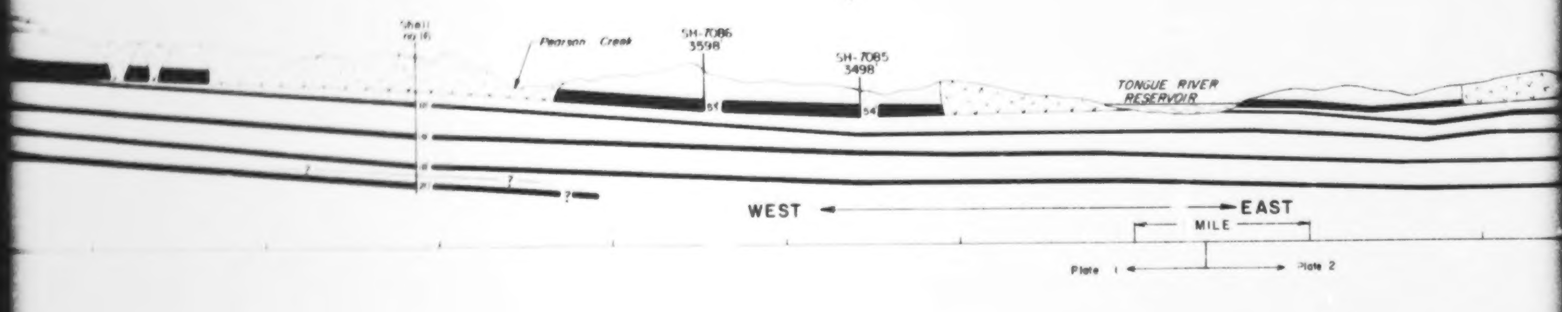

D
SH-7026 4051'
West Fork Waddle Creek
Shell State 41A-36-EG
West Fork Waddle Creek
Smith
Anderson
Dietz no 1
Dietz no 2
Canyon
Wall
Plate 9
Plate 3
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'

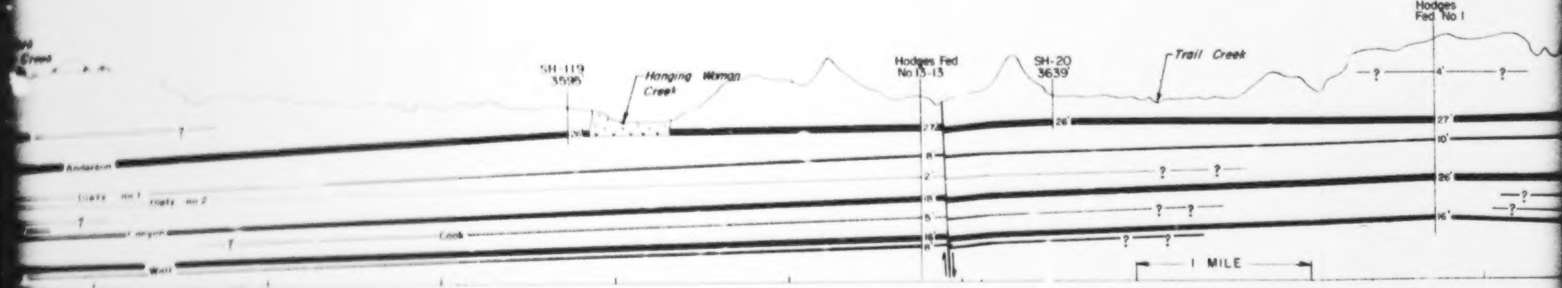

SH-7041 3789'
Bear Creek
SM-18 3925'
SH-7043 3838'
Otter Creek
Pasture Creek
SM-13c 3867'
Bradshaw Creek
4200'
4000'

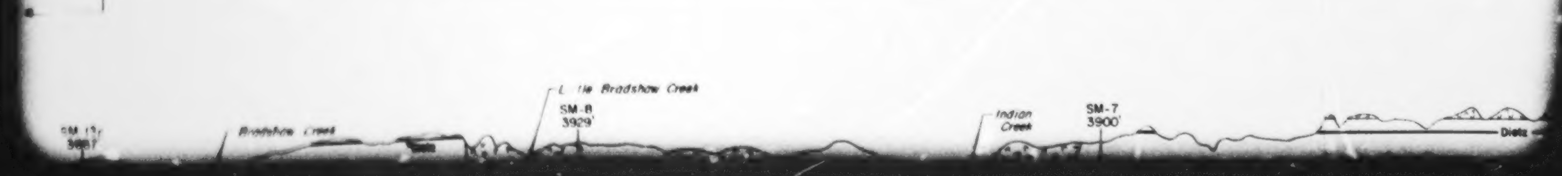
B


South Fork
Otter Creek
South Fork
Canyon Creek
Taylor Fork
Canyon Creek
Canyon
North Fork Canyon Creek
SH-49
3721
WEST
EAST
1 MILE
Plates 5A, B, and C
Plate 6

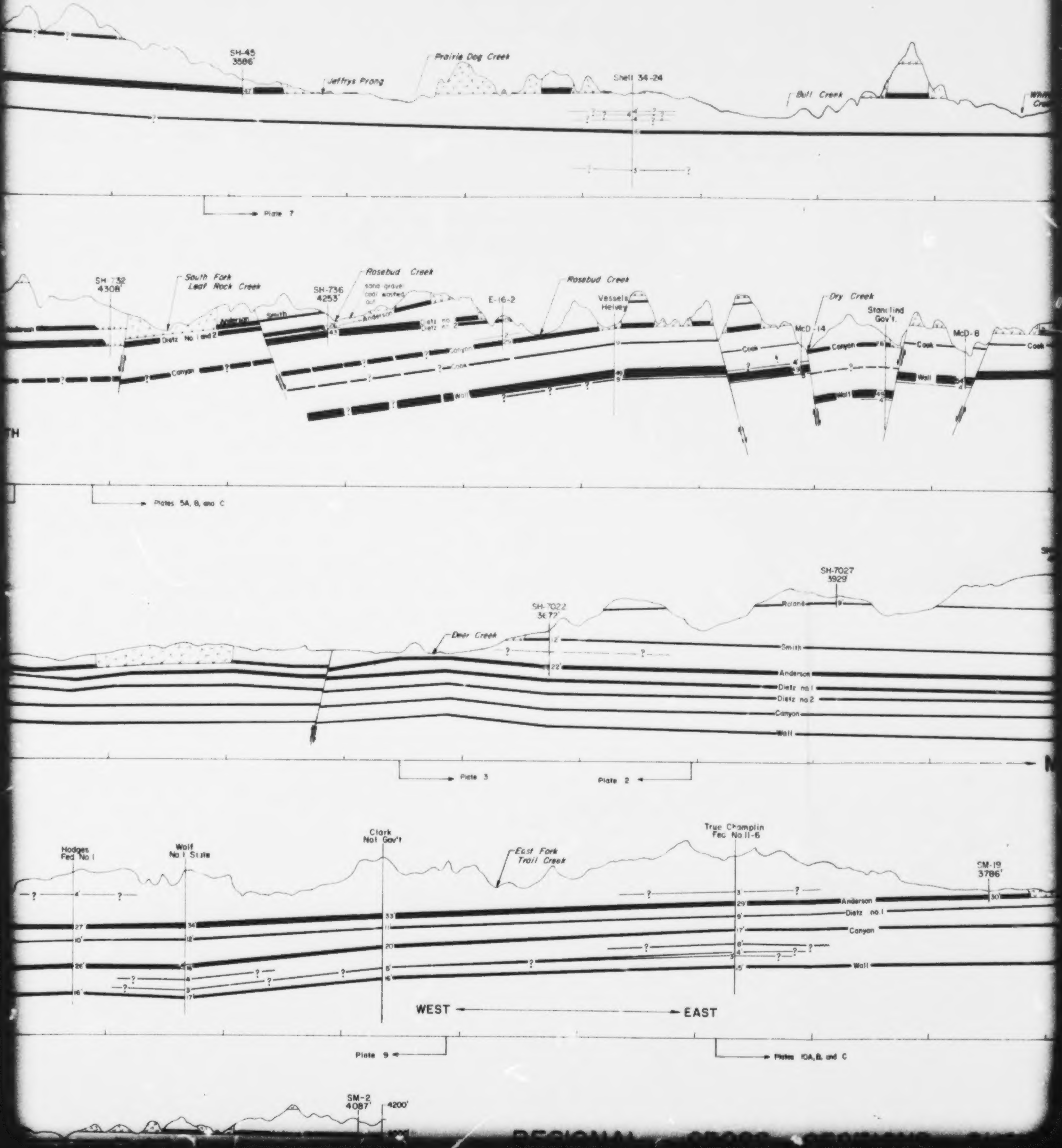

Squirrel Creek
BMC-726
4334
South Fork
Spring Creek
Spring Creek
SH-7017
4246
North Fork
Spring Creek
SH-732
4308'
Anderson
SOUTH
NORTH
1 MILE
Plate 1


Shell
no 16
Pearson Creek
SH-7086
3598
SH-7085
3498'
TONGUE RIVER
RESERVOIR
WEST
EAST
MILE
Plate 1
Plate 2


SH-119
3595
Hanging Woman
Creek
Hodges Fed
No 13-13
SH-20
3639'
Trail Creek
Hodges
Fed No 1
Anderson
Dietz no 1
Dietz no 2
Canyon
Cook
Wall
1 MILE


Little Bradshaw Creek
SM-8
3929'
Bradshaw Creek
Indian
Creek
SM-7
3900'
Dietz

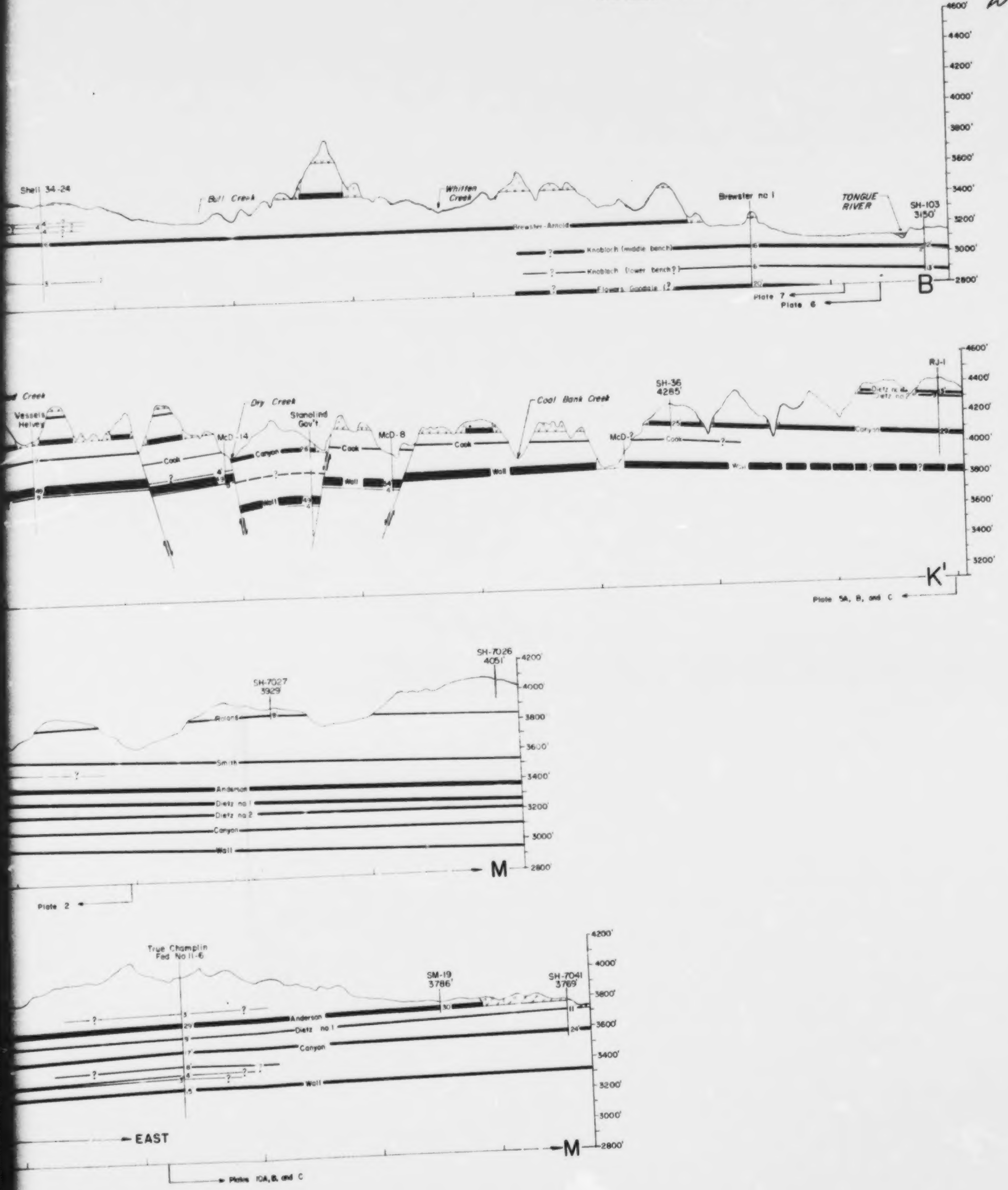
C


SH-45
3586'
Jeffrys Prong
Prairie Dog Creek
Shell 34-24
Bull Creek
Plate 7
SH-732
4308'
South Fork
Leaf Rock Creek
SH-736
4253'
Rosebud Creek
sand gravel
coal washed
out
E-16-2
Rosebud Creek
Vessels
Helvey
Dry Creek
Stanolind
Gov't.
McD-14
McD-8
Anderson
Smith
Dietz No. 1 and 2
Dietz no. 1
Dietz no. 2
Canyon
Cook
Wall
TH
Plates 5A, B, and C
SH-7022
3672'
SH-7027
3929'
Deer Creek
Roland
Smith
Anderson
Dietz no.1
Dietz no.2
Canyon
Wall
Plate 3
Plate 2
Hodges
Fed. No. 1
Wolf
No. 1 State
Clark
No. 1 Gov't
East Fork
Trail Creek
True Champlin
Fed. No. 11-6
SM-19
3786'
Anderson
Dietz no. 1
Canyon
Wall
WEST
EAST
Plate 9
Plates 10A, B, and C
SM-2
4087'
4200'

REGIONAL CROSS SECTIONS

BULLETIN 91 PLATE 33

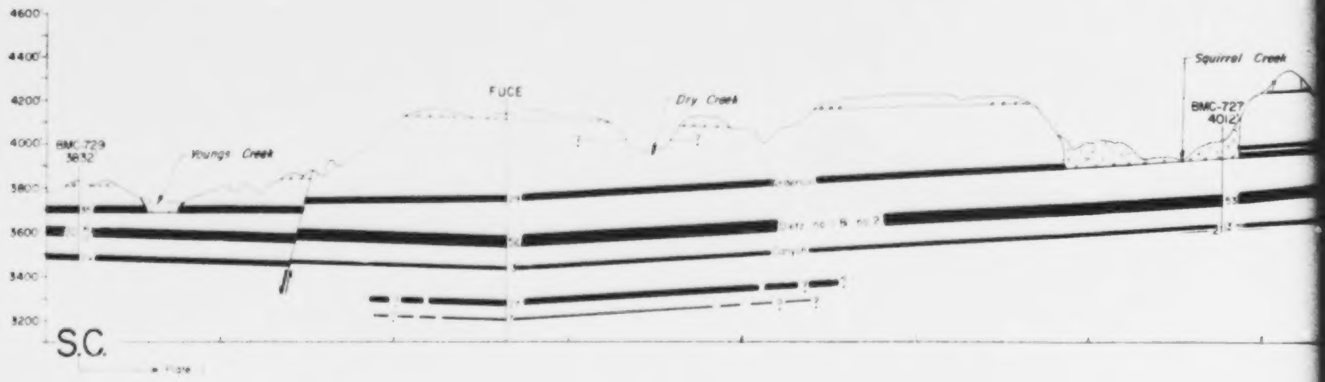
d

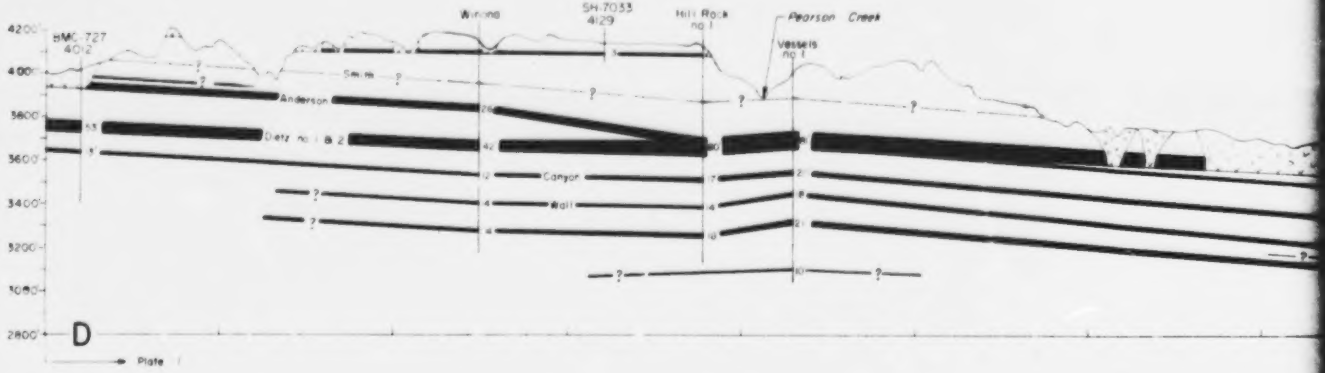


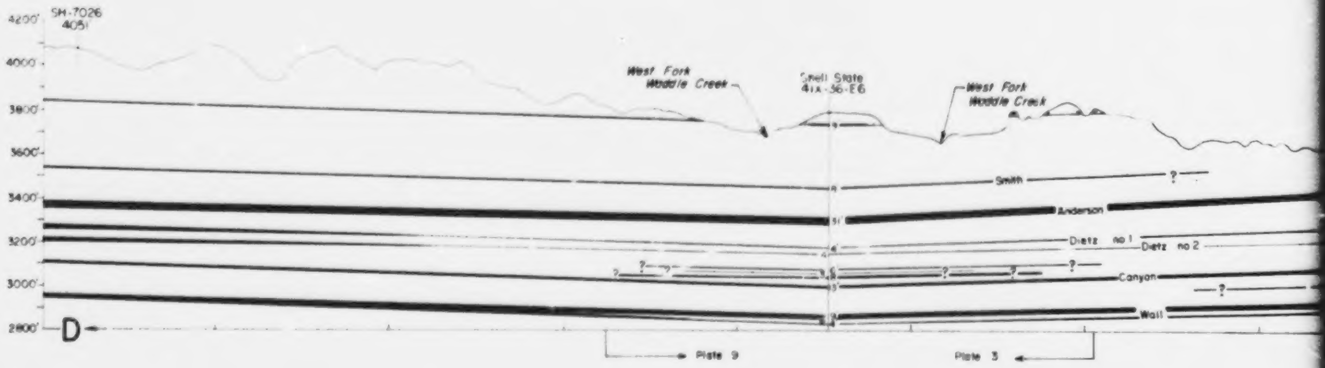
4600'
4400'
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
Shell 34-24
Bull Creek
Whitten Creek
Brewster no 1
TONGUE RIVER
SH-103
3150'
Brewster-Arnold
Knobloch (middle bench)
Knobloch (lower bench?)
Flowers Goodale (?
B
Plate 7
Plate 6
Creek
Vessels Helvey
Dry Creek
Stanolind Gov't
McD-14
McD-8
Coal Bank Creek
SH-36
4285'
McD-2
RJ-1
Dietz no 1
Dietz no 2
Canyon
Cook
Wall
K'
Plate 5A, B, and C
SH-7026
4051'
SH-7027
3929'
Roland
Smith
Anderson
Dietz no 1
Dietz no 2
Canyon
Wall
M
Plate 2
True Champlin
Fed No 11-6
SM-19
3786'
SH-7041
3769'
Anderson
Dietz no 1
Canyon
Wall
EAST
M
Plates 10A, B, and C

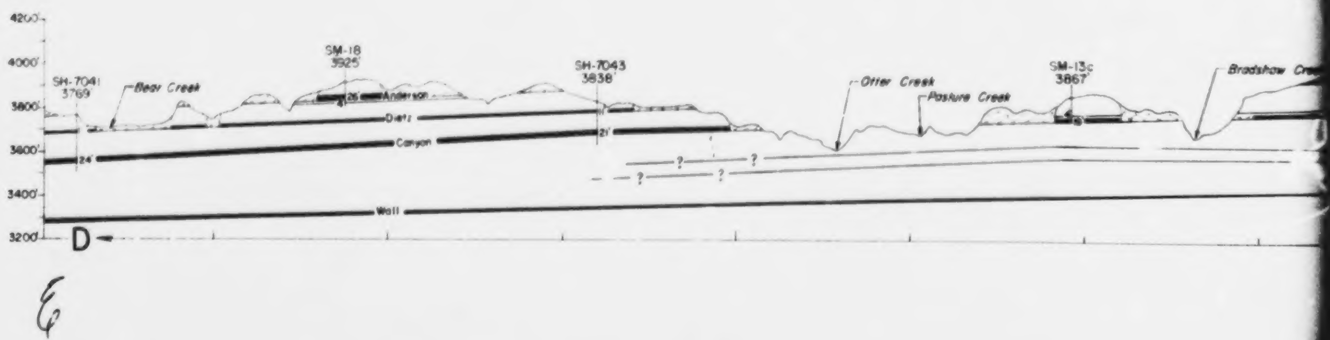
ONAL CROSS SECTIONS SHOWING

3400'
3200'
3000'
2800'
K
Plates 5A, B, and C

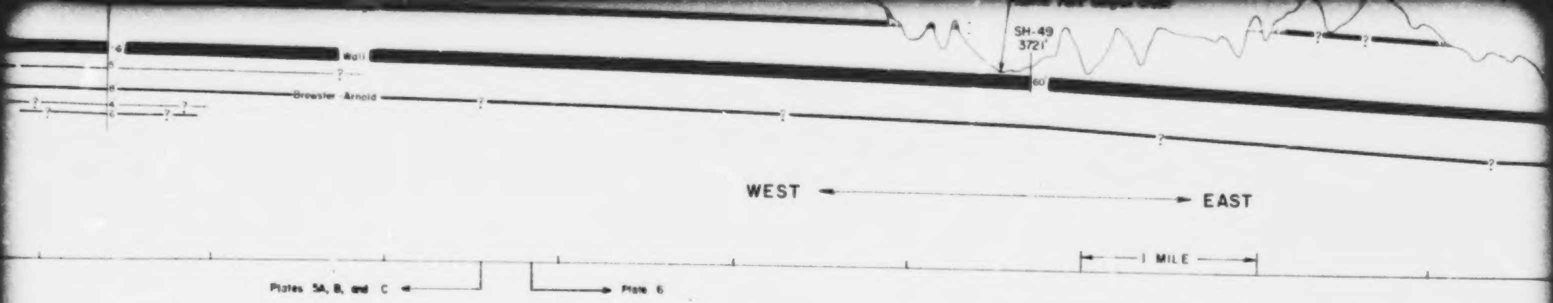

4600'
4400'
4200'
4000'
3800'
3600'
3400'
3200'
BMC-729
3832
Youngs Creek
FUCE
Dry Creek
Squirrel Creek
BMC-727
4012
Anderson
Dietz no 1 & no 2
Canyon
S.C.
Plate 1


4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
BMC-727
4012
Wilting
SH-7033
4129
Hill Rock
no 1
Pearson Creek
Vessels
no 1
Smith
Anderson
Dietz no 1 & 2
Canyon
Wall
D
Plate 1

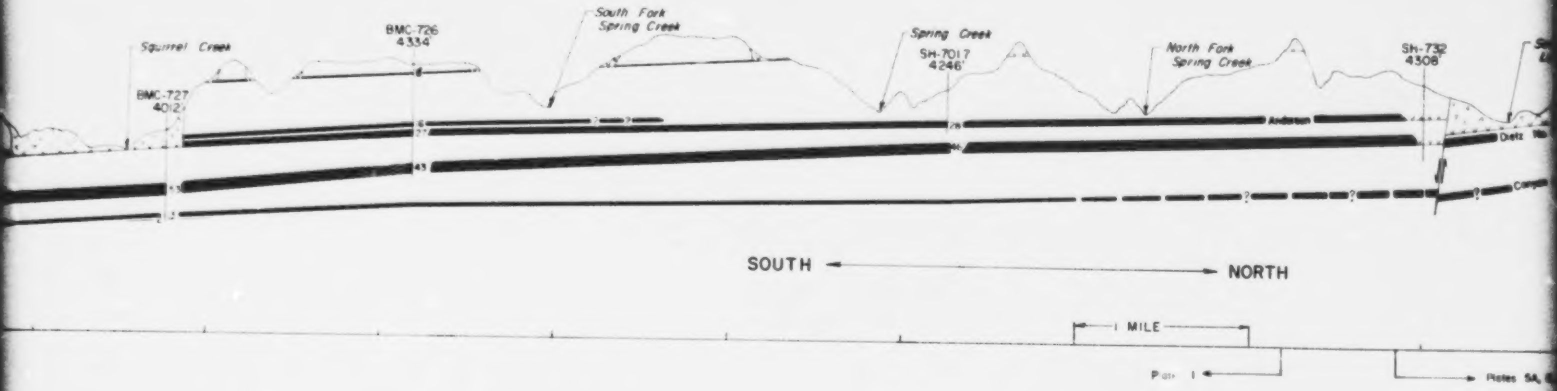

4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
SH-7026
4051
West Fork
Waddle Creek
Shell State
41x-36-E6
West Fork
Waddle Creek
Smith
Anderson
Dietz no 1
Dietz no 2
Canyon
Wall
D
Plate 9
Plate 3


4200'
4000'
3800'
3600'
3400'
3200'
SH-7041
3769
Bear Creek
SM-18
3925'
Anderson
Dietz
Canyon
SH-7043
3838'
Otter Creek
Pasture Creek
SM-13c
3867'
Bradshaw Creek
Wall
D

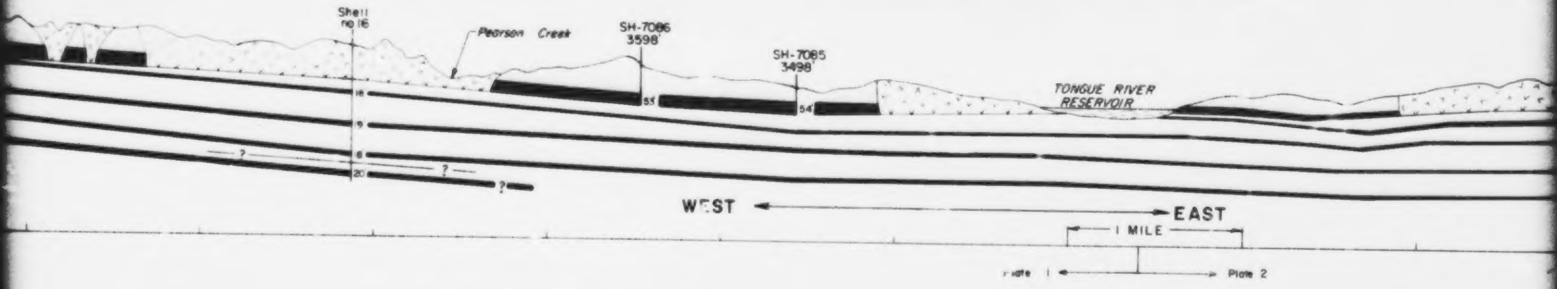
E



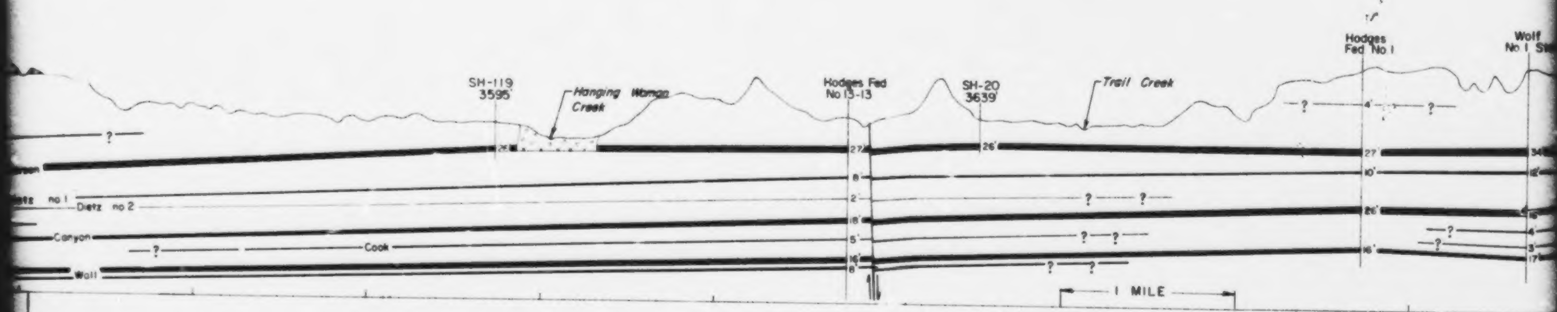
SH-49
3721'
Wall
Brewster-Arnold
60
WEST
EAST
1 MILE
Plates 5A, B, and C
Plate 6



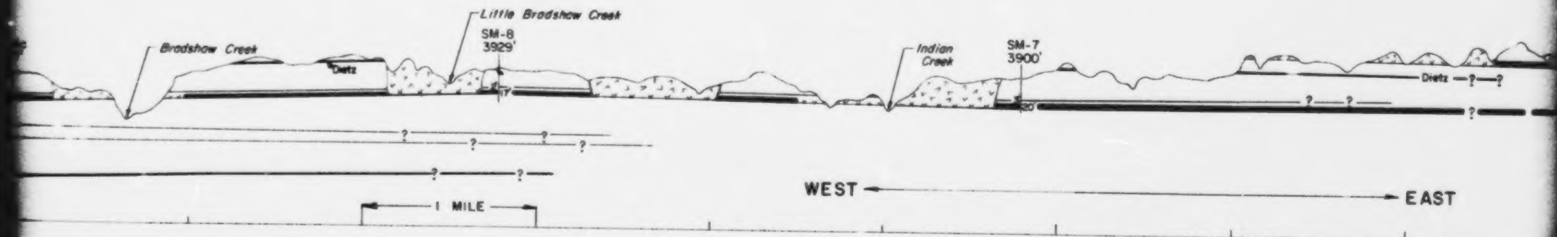
Squirrel Creek
BMC-727
4012'
BMC-726
4334'
South Fork Spring Creek
Spring Creek
SH-7017
4246'
North Fork Spring Creek
SH-732
4308'
Anderson
Dietz No
Canyon
27
43
53
SOUTH
NORTH
1 MILE
Plate 1
Plates 5A, B



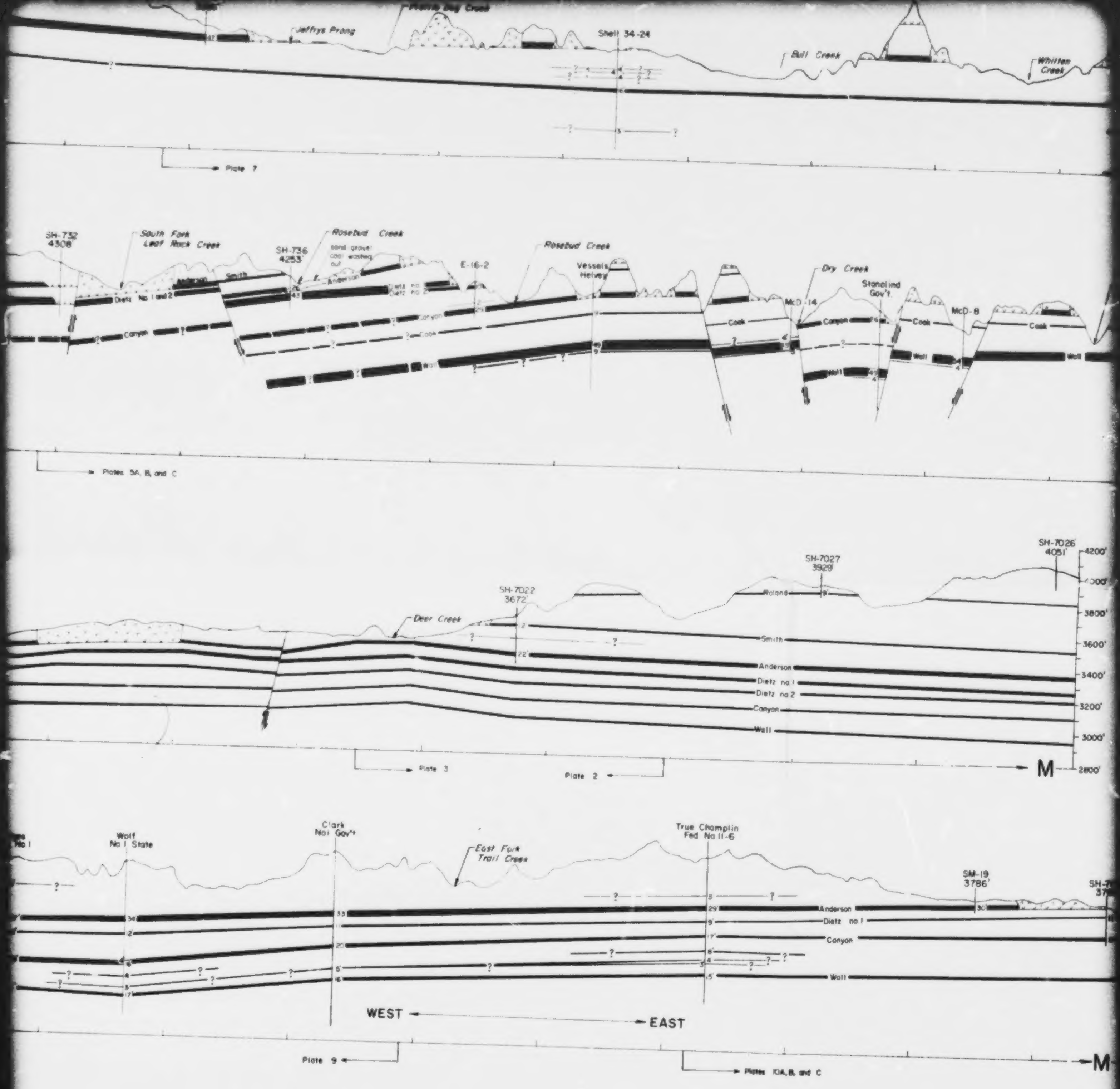
Shell no 16
Pearson Creek
SH-7086
3598'
SH-7085
3498'
TONGUE RIVER RESERVOIR
16
9
6
20
53
54
WEST
EAST
1 MILE
Plate 1
Plate 2

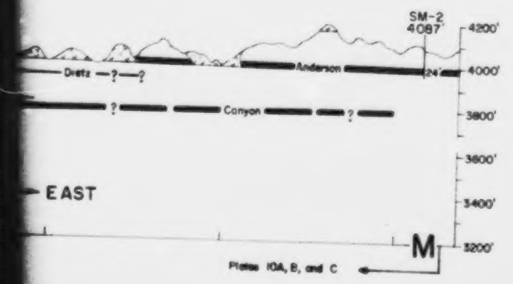


SH-119
3595'
Hanging Woman Creek
Hodges Fed No 13-13
SH-20
3639'
Trail Creek
Hodges Fed No 1
Wolf No 1
Dietz no 1
Dietz no 2
Canyon
Cook
Wall
26
27
8
2
18
5
16
26'
27
10'
26'
16'
34
18
4
3
17
1 MILE



Little Bradshaw Creek
Bradshow Creek
Dietz
SM-8
3929'
17
Indian Creek
SM-7
3900'
20
Dietz
WEST
EAST
1 MILE


Prairie Dog Creek
Jeffrys Prong
Shell 34-24
Bull Creek
Whitten Creek
Plate 7
SH-732
4308'
South Fork Leaf Rock Creek
SH-736
4253'
Rosebud Creek
sand gravel coal washed out
Rosebud Creek
E-16-2
Vessels Helvey
Dry Creek
McD-14
Stanolind Gov't.
McD-8
Anderson
Smith
Dietz No 1 and 2
Dietz no 1
Dietz no 2
Canyon
Cook
Wall
Plates 5A, B, and C
SH-7026
4051'
SH-7027
3929'
SH-7022
3672'
Deer Creek
Roland
Smith
Anderson
Dietz no 1
Dietz no 2
Canyon
Wall
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
Plate 3
Plate 2
M
Wolf No 1 State
Clark No 1 Gov't
East Fork Trail Creek
True Champlin Fed No 11-6
SM-19
3786'
Anderson
Dietz no 1
Canyon
Wall
WEST
EAST
Plate 9
Plates 10A, B, and C
M


SM-2
4087'
Anderson
Dietz
Canyon
EAST
4200'
4000'
3800'
3600'
3400'
3200'
M
Plates 10A, B, and C

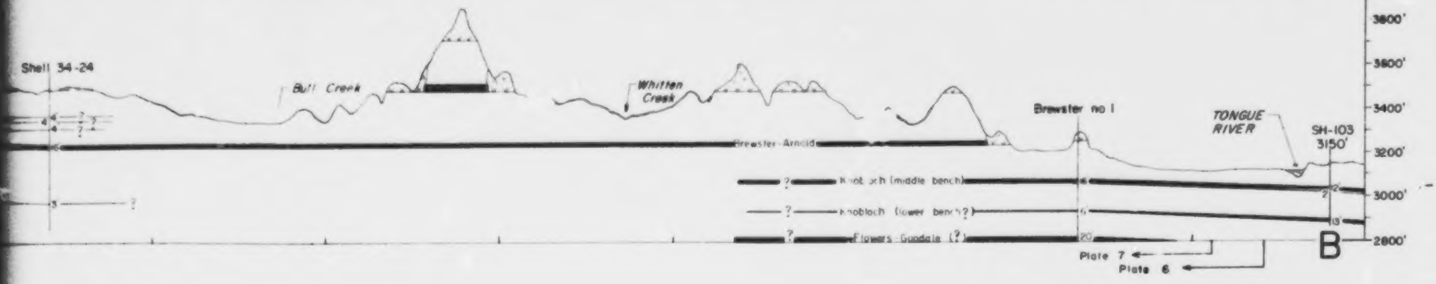
REGIONAL CROSS SECTIONS SHOWING STRUCTURE AND CORRELATION

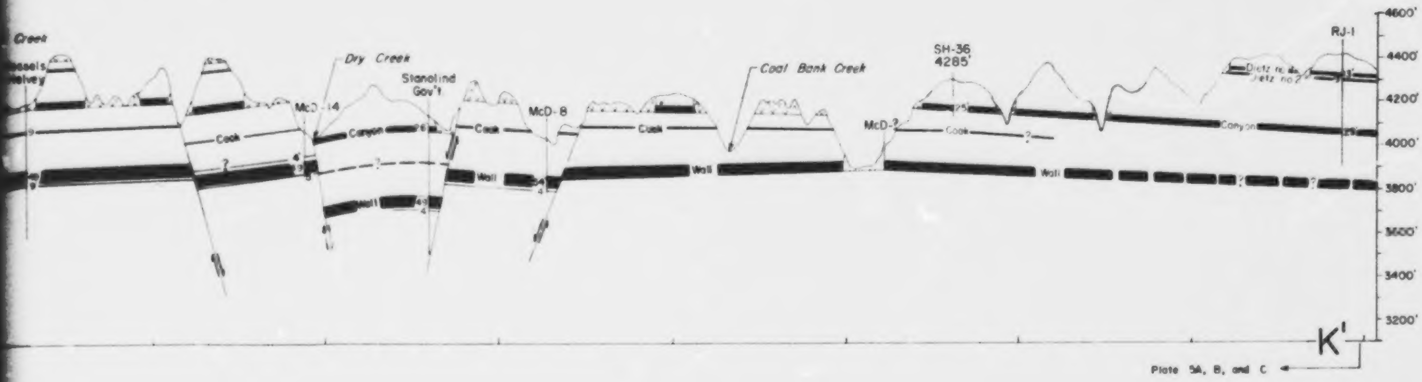
Vertical exag. $\frac{2{,}000'}{300'} = 6\frac{2}{3}$

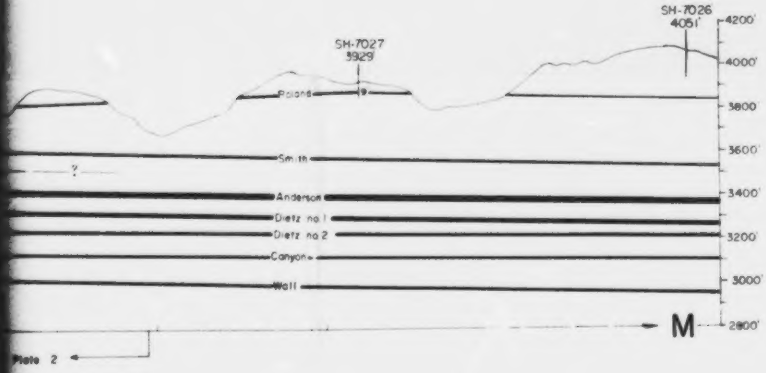
300 ft.

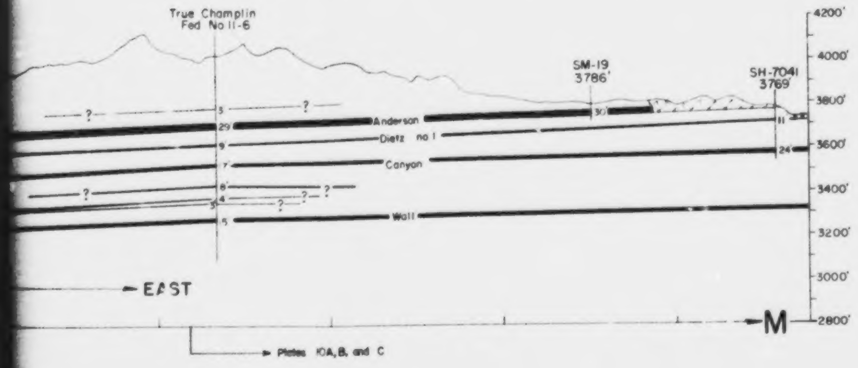
2,000 ft.

9


Shell 34-24
Bull Creek
Whitten Creek
Brewster no 1
TONGUE RIVER
SH-103
3150'
Brewster-Arnold
Knobloch (middle bench)
Knobloch (lower bench ?)
Flowers-Goodale (?)
Plate 7
Plate 6
B
4000'
3800'
3600'
3400'
3200'
3000'
2800'


Creek
Dry Creek
Stanolind Gov't
Coal Bank Creek
SH-36
4285'
RJ-1
McD-14
McD-8
McD-2
Cook
Canyon
Wall
Dietz no 1
Dietz no 2
K'
Plate 5A, B, and C
4600'
4400'
4200'
4000'
3800'
3600'
3400'
3200'


SH-7026
4051'
SH-7027
3929'
Roland
Smith
Anderson
Dietz no 1
Dietz no 2
Canyon
Wall
M
Plate 2
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'


True Champlin
Fed No 11-6
SM-19
3786'
SH-7041
3769'
Anderson
Dietz no 1
Canyon
Wall
EAST
M
Plates 10A, B, and C
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'

NAL CROSS SECTIONS SHOWING
UCTURE AND CORRELATION

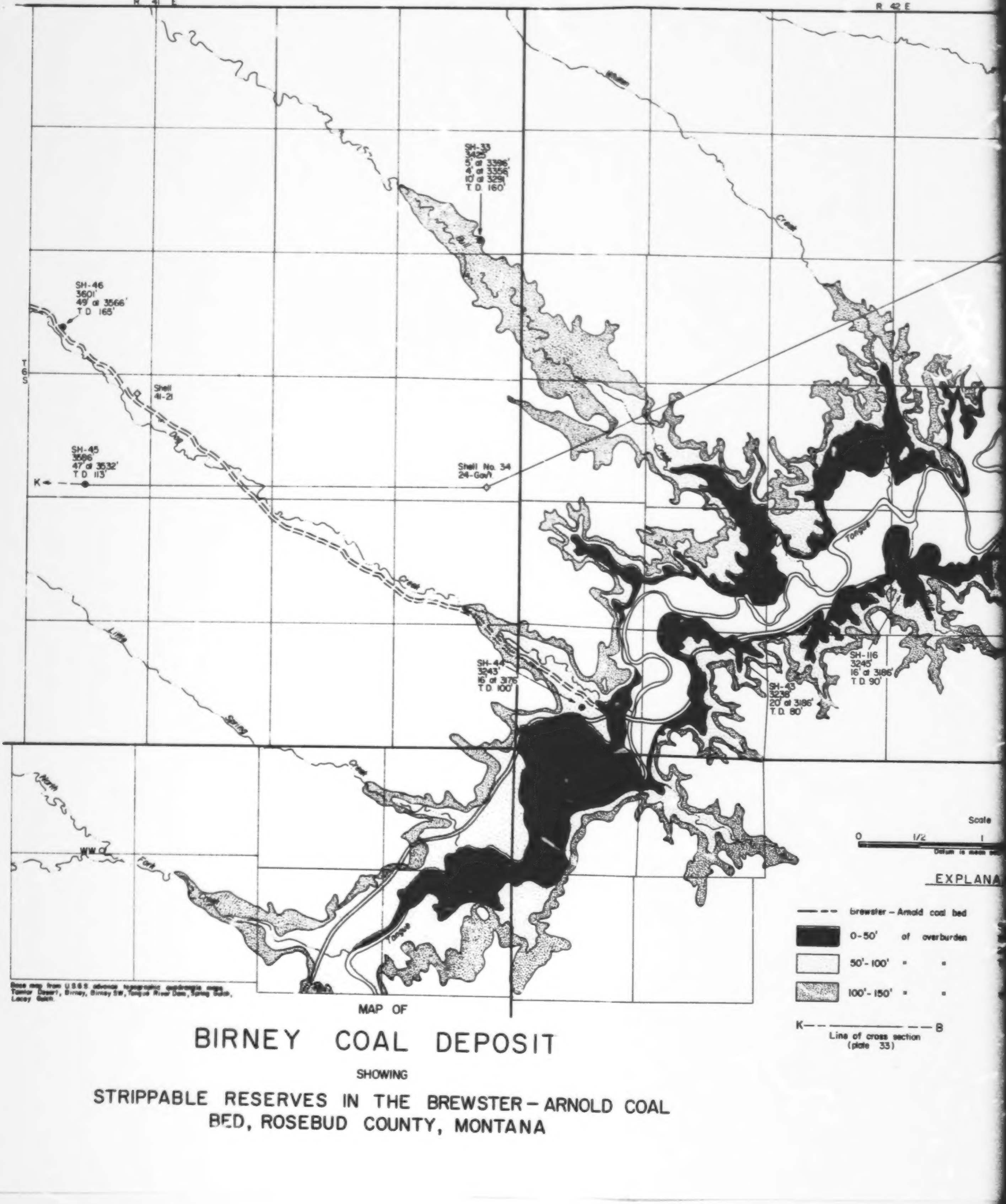
Vertical Exag. $\frac{2{,}000'}{300'} = 6\frac{2}{3}$

300 ft

2,000 ft

A

MONTANA BUREAU OF MINES AND GEOLOGY


R 41 E
R 42 E
T 6 S
SH-33
3425'
5' at 3396'
4' at 3356'
10' at 3291
T.D. 160'
SH-46
3601'
49' at 3566'
T D 165'
Shell
41-21
SH-45
3586'
47' at 3532'
T D 113'
K
Shell No. 34
24-Gov't
Bull
Dog
Creek
Creek
Tongue
Little
Spring
Creek
North
Fork
W.W.
Tongue
SH-44
3243'
16' at 3176
T.D. 100'
SH-43
3238'
20' at 3186'
T.D. 80'
SH-116
3245'
16' at 3186'
T.D. 90'
Scale
0
1/2
1
Datum is mean sea
EXPLANA
Brewster - Arnold coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
K—— ——B
Line of cross section (plate 33)

Base map from U.S.G.S. advance topographic quadrangle maps: Tamar Desert, Birney, Birney SW, Tongue River Dam, Spring Gulch, Lacey Gulch.

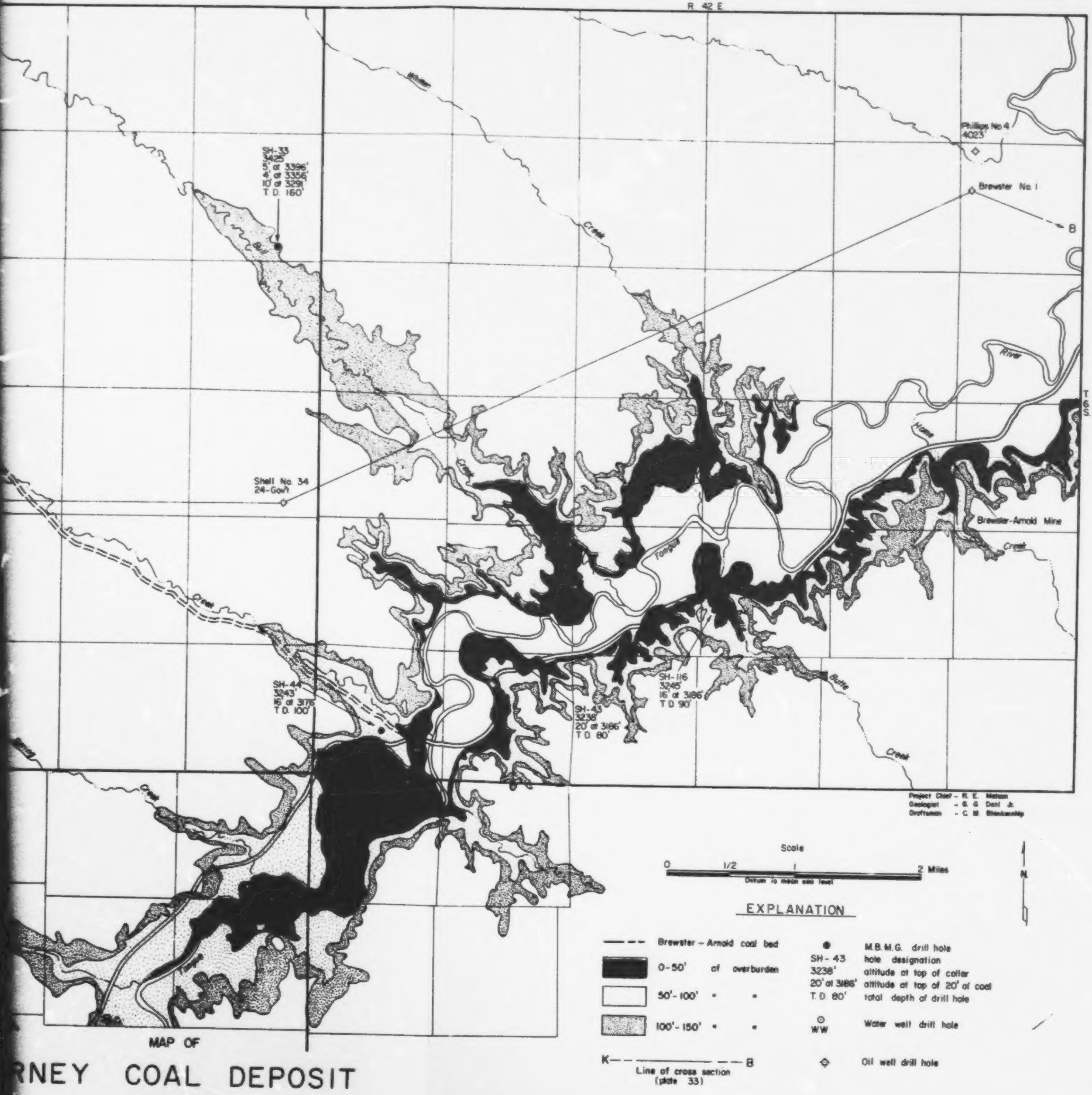
MAP OF

BIRNEY COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE BREWSTER-ARNOLD COAL
BED, ROSEBUD COUNTY, MONTANA

B


R. 42 E.
T. 6 S.
Phillips No. 4
4023
Brewster No. 1
B
SH-33
3425
5' at 3396'
4' at 3356'
10' at 3291
T. D. 160'
Shell No. 34
24-Gov't.
Creek
River
Tongue
Brewster-Arnold Mine
Creek
SH-116
3245'
16' at 3186'
T. D. 90'
SH-43
3238'
20' at 3186'
T. D. 80'
SH-44
3243'
16' at 3176'
T. D. 100'
Butte
Creek
Creek
Project Chief - R. E. Matson
Geologist - G. G. Dahl Jr.
Draftsman - C. M. Blankenship
Scale
0
1/2
1
2 Miles
Datum is mean sea level
N
EXPLANATION
Brewster - Arnold coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
K— — B
Line of cross section
(plate 33)
M.B.M.G. drill hole
SH - 43 hole designation
3238' altitude at top of collar
20' at 3186' altitude at top of 20' of coal
T. D. 80' total depth of drill hole
WW Water well drill hole
Oil well drill hole

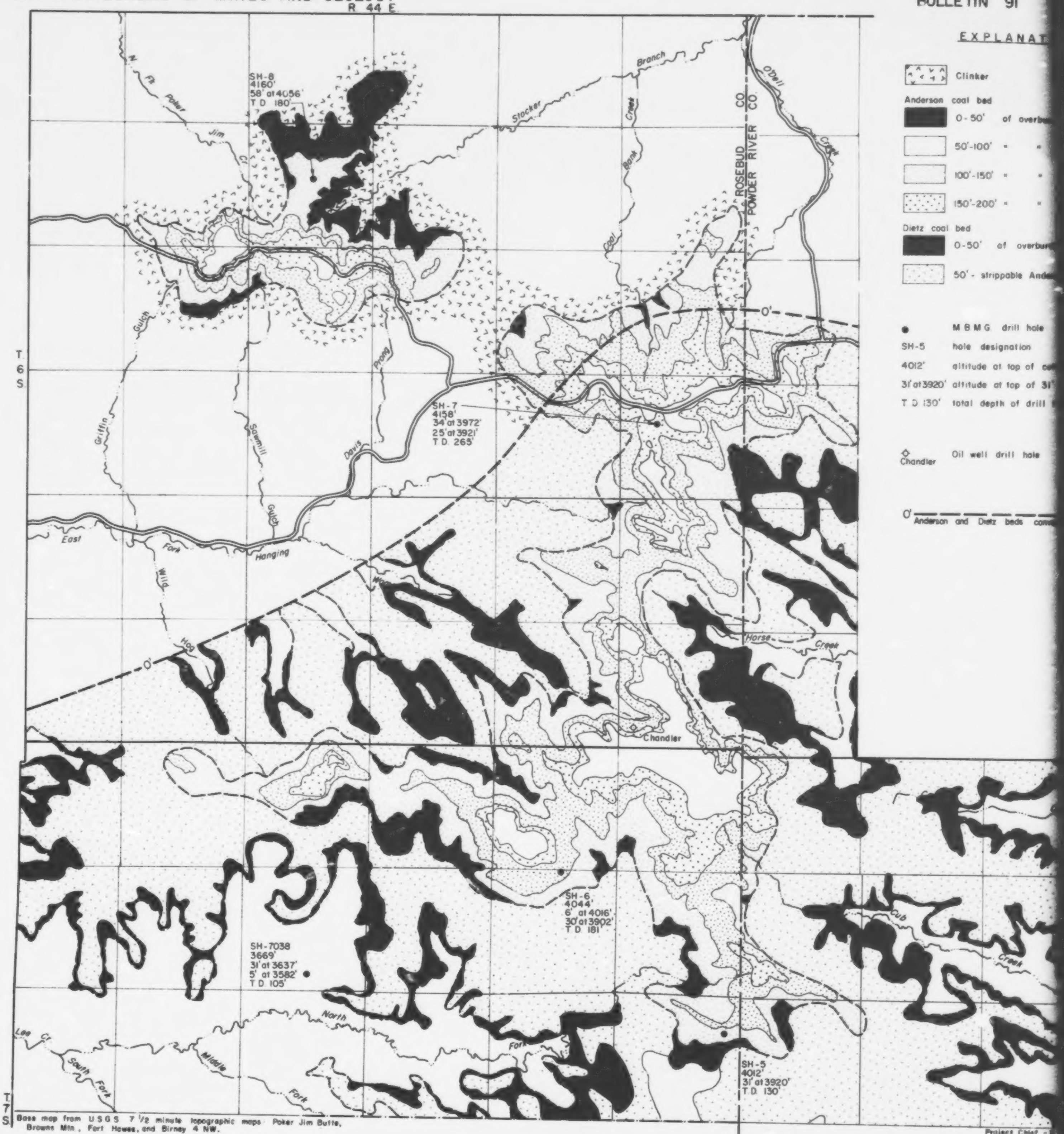
MAP OF

RNEY COAL DEPOSIT

SHOWING

RESERVES IN THE BREWSTER - ARNOLD COAL
D, ROSEBUD COUNTY, MONTANA

H


R 44 E
EXPLANAT
Clinker
Anderson coal bed
0-50' of overbu
50'-100' " "
100'-150' " "
150'-200' " "
Dietz coal bed
0-50' of overbur
50' - strippable And
● M B M G drill hole
SH-5 hole designation
4012' altitude at top of co
31' at 3920' altitude at top of 31
T D 130' total depth of drill
◇ Chandler Oil well drill hole
0' Anderson and Dietz beds conv
T. 6 S
T. 7 S
ROSEBUD CO
POWDER RIVER CO
SH-8
4160'
58' at 4056'
T D 180'
SH-7
4158'
34' at 3972'
25' at 3921'
T.D. 265'
SH-6
4044'
6' at 4016'
30' at 3902'
T.D. 181'
SH-7038
3669'
31' at 3637'
5' at 3582'
T.D. 105'
SH-5
4012'
31' at 3920'
T.D. 130'
Chandler
0'
N. Fk. Poker Jim Cr.
Stocker Branch
O'Dell Creek
Coal Bank Creek
Gulch
Griffin
Prong
Sawmill Gulch
Davis
East Fork Hanging Wo
Wild Hog
Horse Creek
Cub Creek
North Fork
Lee Cr.
South Fork
Middle Fork

Base map from U S G S 7 1/2 minute topographic maps Poker Jim Butte, Browns Mtn., Fort Howes, and Birney 4 NW.

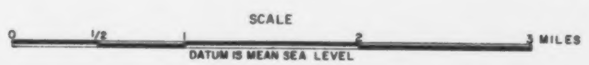
Project Chief -
Geologist -
Draftsman -

MAP OF

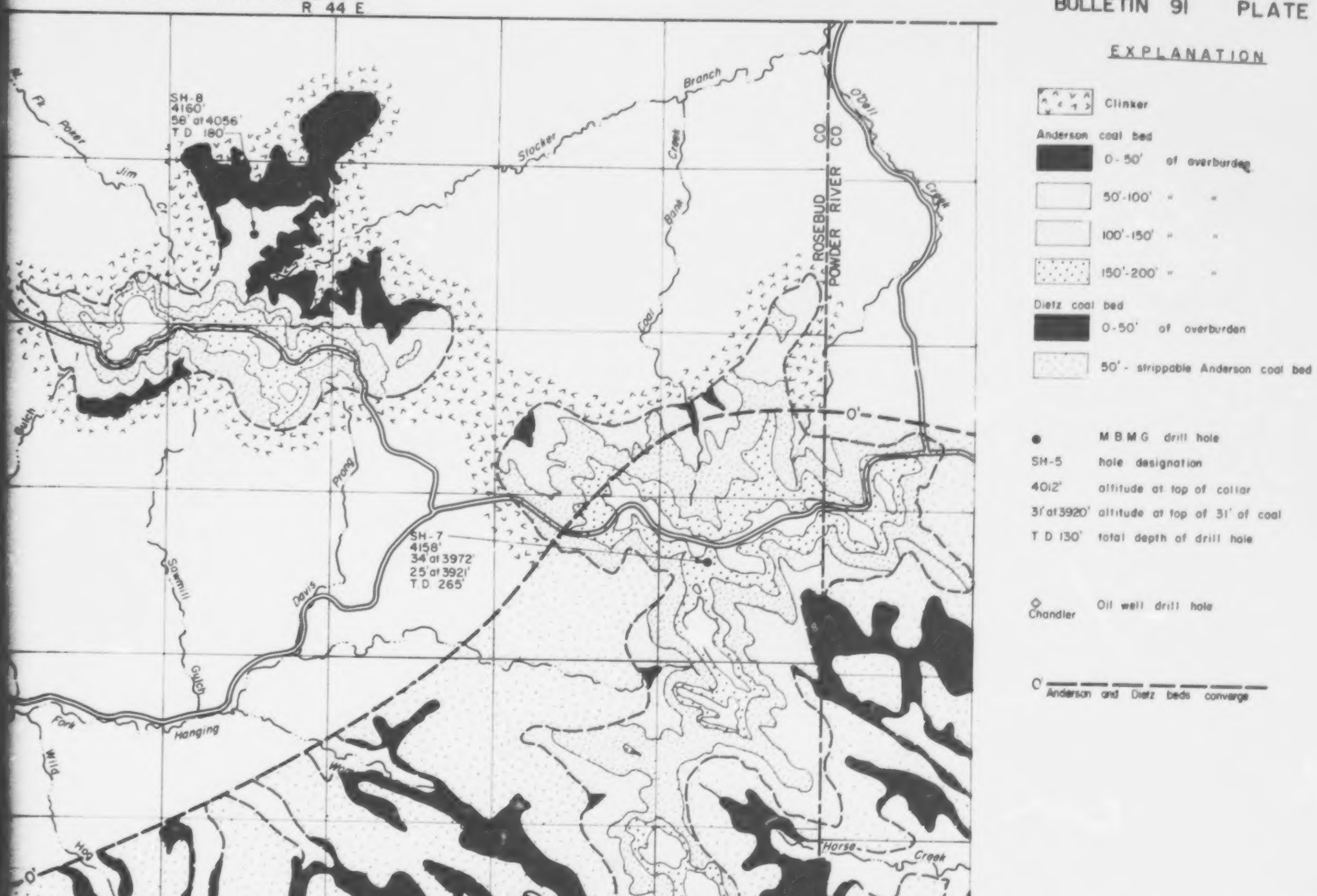
POKER JIM LOOKOUT COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE ANDERSON AND DIETZ COAL BEDS, ROSEBUD AND POWDER RIVER COUNTIES, MONTANA


SCALE
0
1/2
1
2
3 MILES
DATUM IS MEAN SEA LEVEL

B


R 44 E
R 45 E
EXPLANATION
Clinker
Anderson coal bed
0-50' of overburden
50'-100' " "
100'-150' " "
150'-200' " "
Dietz coal bed
0-50' of overburden
50' - strippable Anderson coal bed
MBMG drill hole
SH-5 hole designation
4012' altitude at top of collar
31' at 3920' altitude at top of 31' of coal
T D 130' total depth of drill hole
Chandler Oil well drill hole
0' Anderson and Dietz beds converge
ROSEBUD CO
POWDER RIVER CO
SH-8
4160'
56' at 4056'
T D 180'
SH-7
4158'
34' at 3972'
25' at 3921'
T D 265'
SH-6
4044'
6' at 4016'
30' at 3902'
T D 181'
SH-7C38
3669'
31' at 3637'
5' at 3582'
T D 105'
SH-5
4012'
31' at 3920'
T D 130'
Chandler
Poker Jim Cr
Slocker Branch
Bank Creek
Coal
O'Dell Creek
Davis Prong
Sawmill Gulch
Gulch
Hanging
Fork
Wild
Hog
Horse Creek
Creek
Cub Creek
North Fork
Middle Fork
0'

/2 minute topographic maps Poker Jim Butte,
and Birney 4 NW.

Project Chief - R. E. Matson
Geologist - W. A. Van Voast
Draftsman - E. A. Woods

MAP OF

POKER JIM LOOKOUT COAL DEPOSIT

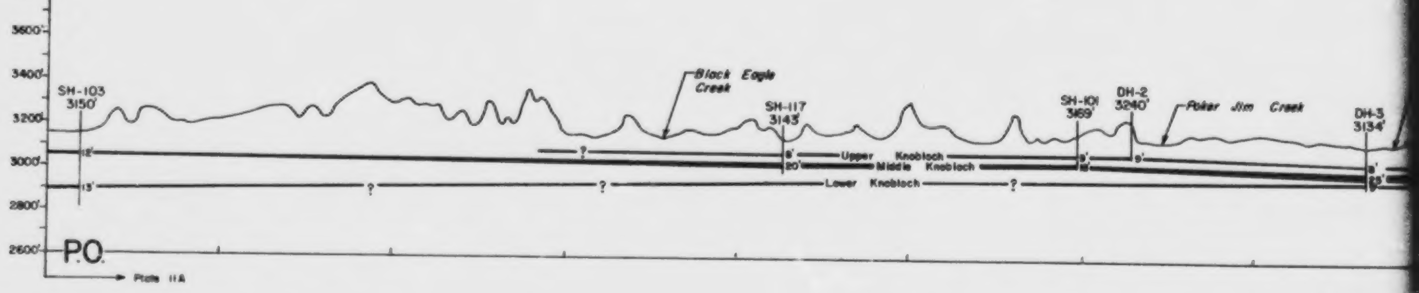
SHOWING

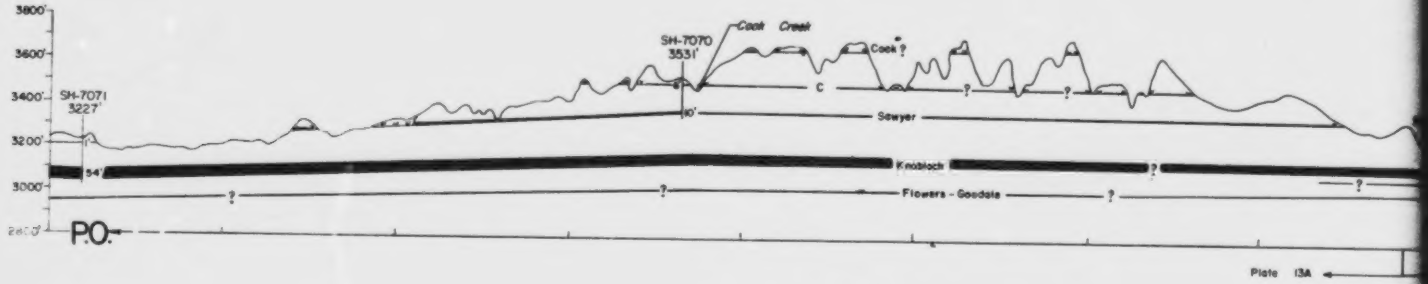
STRIPPABLE RESERVES IN THE ANDERSON AND DIETZ COAL BEDS, ROSEBUD AND POWDER RIVER COUNTIES, MONTANA

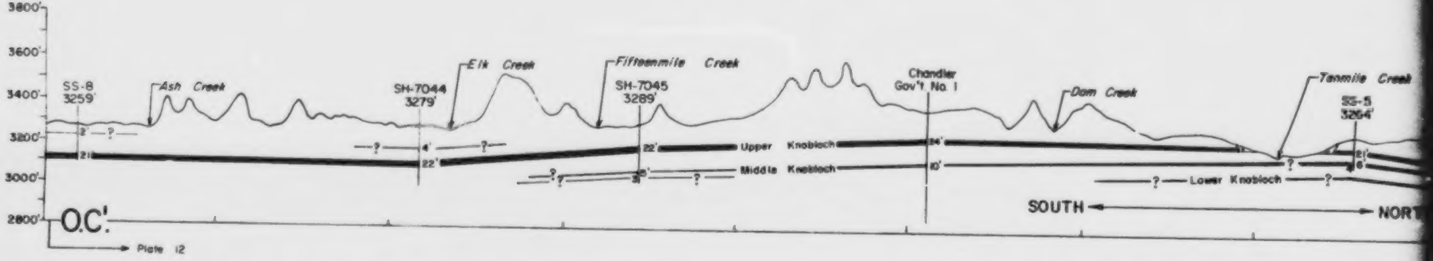
SCALE
0 1/2 1 2 3 MILES
DATUM IS MEAN SEA LEVEL

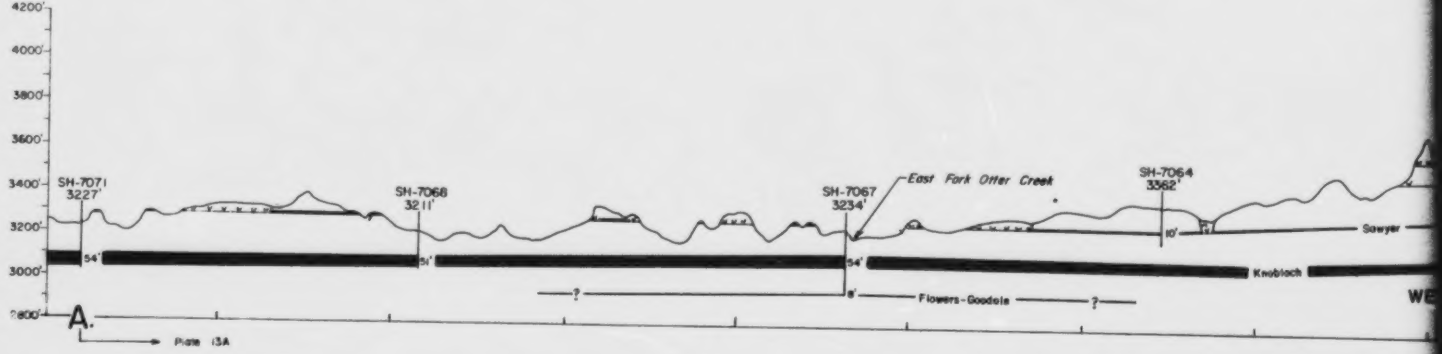
A

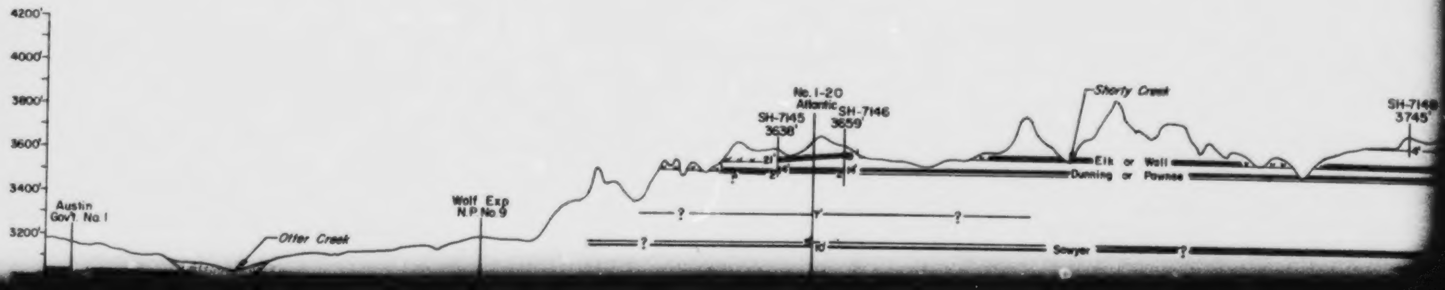
MONTANA BUREAU OF MINES AND GEOLOGY


3800'
3600'
3400'
3200'
3000'
2800'
2600'
SH-103
3150'
Black Eagle Creek
SH-117
3143'
SH-101
3169'
DH-2
3240'
Poker Jim Creek
DH-3
3134'
Upper Knobloch
Middle Knobloch
Lower Knobloch
P.O.
Plate 11A

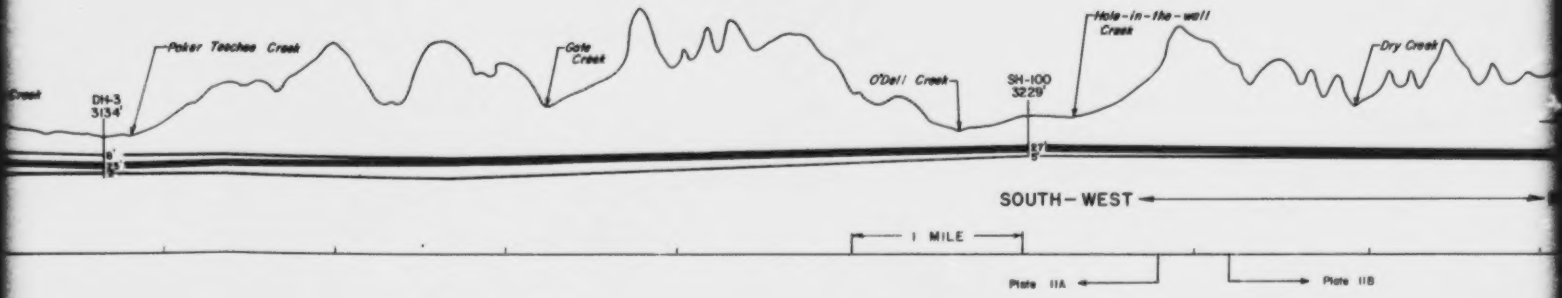

3800'
3600'
3400'
3200'
3000'
2800'
SH-7071
3227'
SH-7070
3531'
Cook Creek
Cook ?
C
Sawyer
Knobloch
Flowers - Goodale
P.O.
Plate 13A

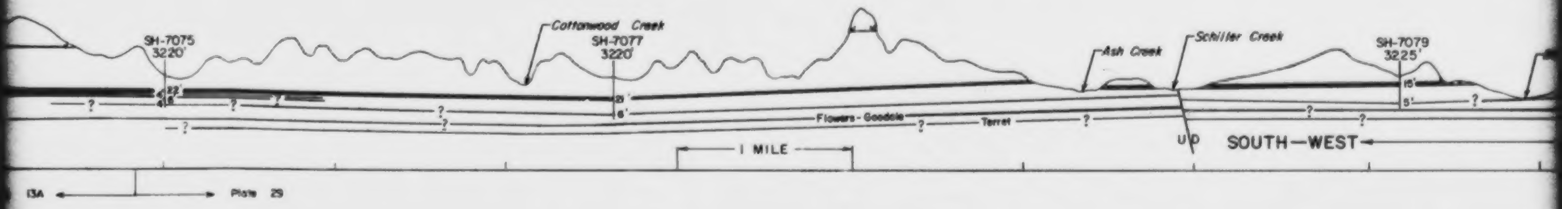

3800'
3600'
3400'
3200'
3000'
2800'
SS-8
3259'
Ash Creek
SH-7044
3279'
Elk Creek
Fifteenmile Creek
SH-7045
3289'
Chandler
Gov't No. 1
Dam Creek
Tenmile Creek
SS-5
3264'
Upper Knobloch
Middle Knobloch
Lower Knobloch
SOUTH
NORT
O.C'.
Plate 12

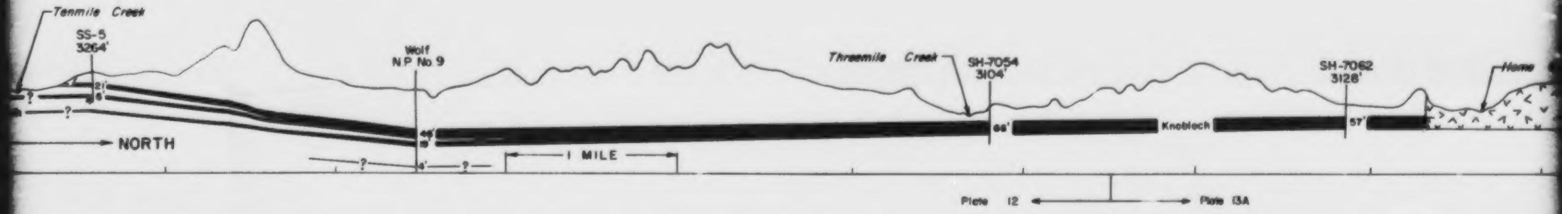

4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
SH-7071
3227'
SH-7068
3211'
SH-7067
3234'
East Fork Otter Creek
SH-7064
3362'
Sawyer
Knobloch
Flowers - Goodale
WE
A.
Plate 13A

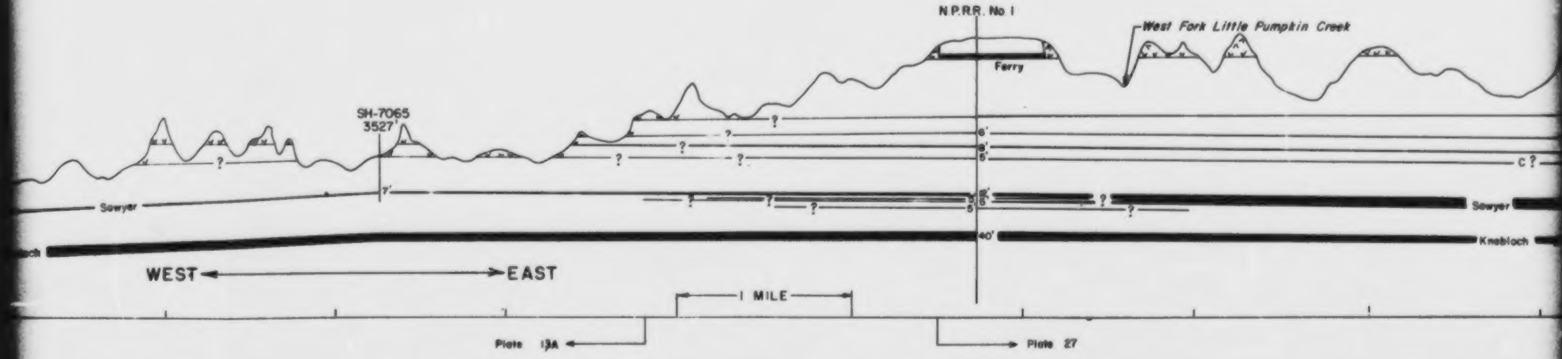

4200'
4000'
3800'
3600'
3400'
3200'
Austin
Gov't No. 1
Otter Creek
Wolf Exp
N.P. No. 9
SH-7145
3638'
No. 1-20
Atlantic
SH-7146
3659'
Shorty Creek
SH-7148
3745'
Elk or Wall
Dunning or Pawnee
Sawyer

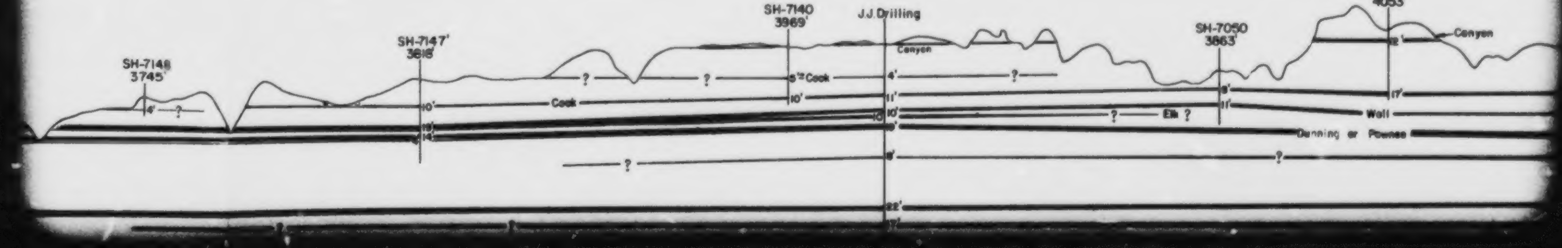
B


Creek
DH-3
3134'
Poker Teeshee Creek
Gate Creek
O'Dell Creek
SH-100
3229'
Hole-in-the-wall Creek
Dry Creek
27'
5'
SOUTH-WEST
1 MILE
Plate 11A
Plate 11B


SH-7075
3220'
Cottonwood Creek
SH-7077
3220'
Ash Creek
Schiller Creek
SH-7079
3225'
22'
21'
6'
15'
5'
?
Flowers-Goodale
Terret
U D
SOUTH-WEST
1 MILE
13A
Plate 29

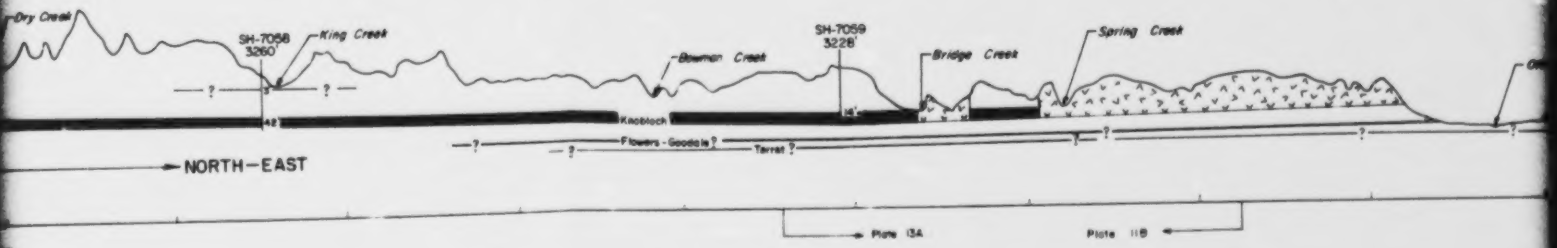

Tenmile Creek
SS-5
3264'
Wolf
N.P. No.9
Threemile Creek
SH-7054
3104'
SH-7062
3128'
Home
21'
6'
46'
4'
66'
57'
Knobloch
?
NORTH
1 MILE
Plate 12
Plate 13A

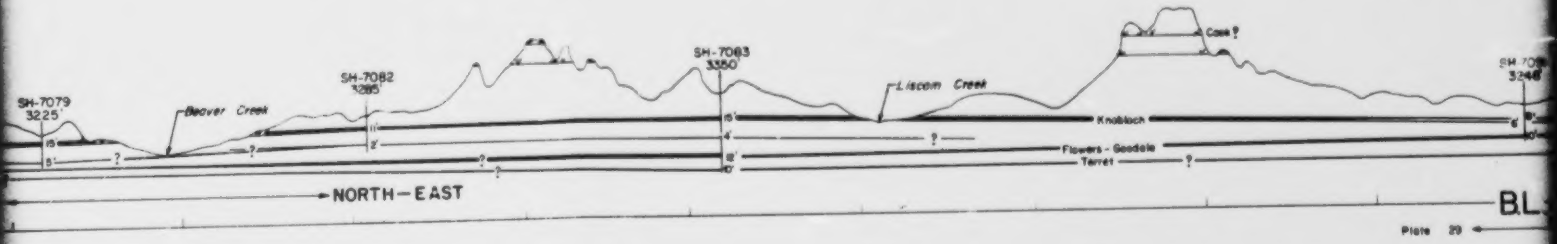

N.P.R.R. No. 1
West Fork Little Pumpkin Creek
Ferry
SH-7065
3527'
7'
6'
8'
5'
40'
?
C ?
Sawyer
Knobloch
WEST
EAST
1 MILE
Plate 13A
Plate 27

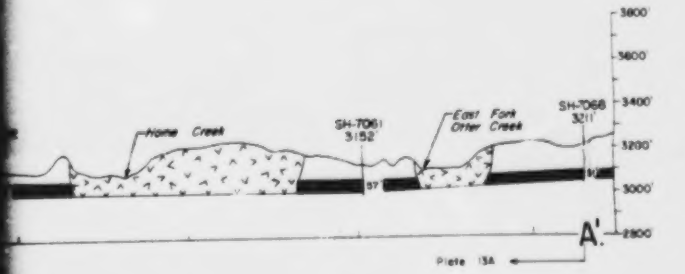

SH-7148
3745'
SH-7147
3616'
SH-7140
3969'
J.J. Drilling
SH-7050
3863'
SH-7141
4053'
Canyon
Cook
Elk
Wall
Dunning or Pawnee
4'
10'
11'
8'
17'
12'
22'
?

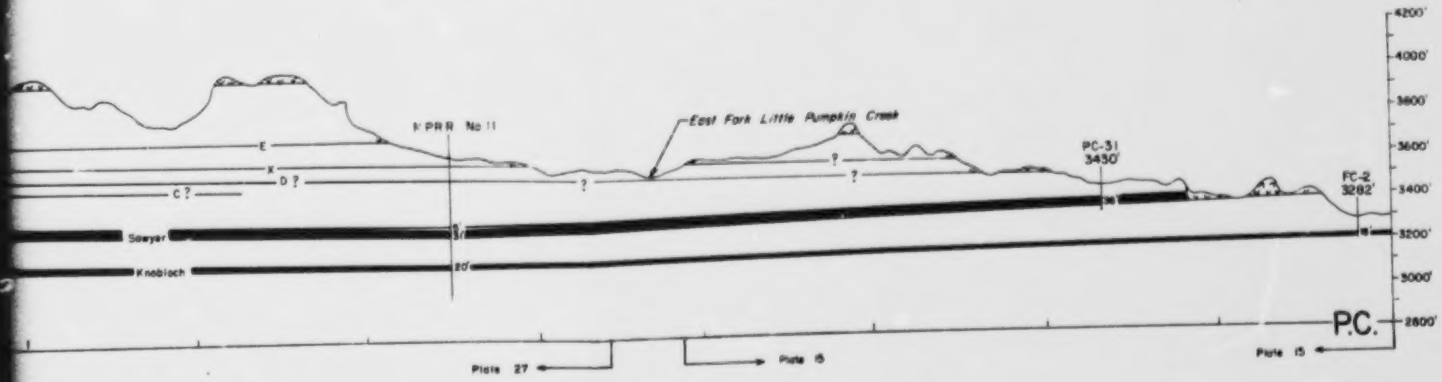
C

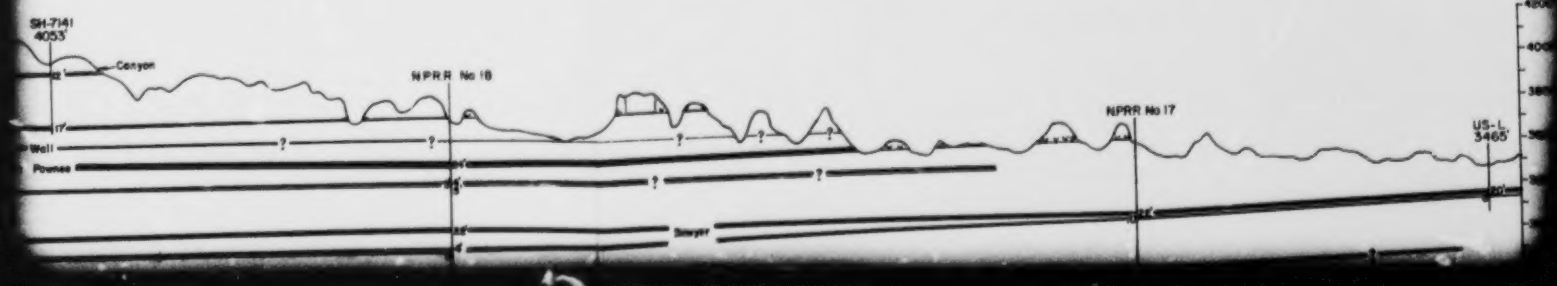
BULLETIN


Dry Creek
SH-7058
3260'
King Creek
Bowman Creek
SH-7059
3228'
Bridge Creek
Spring Creek
42'
14'
Knobloch
Flowers - Goodale ?
Tarret ?
NORTH-EAST
Plate 13A
Plate 11B

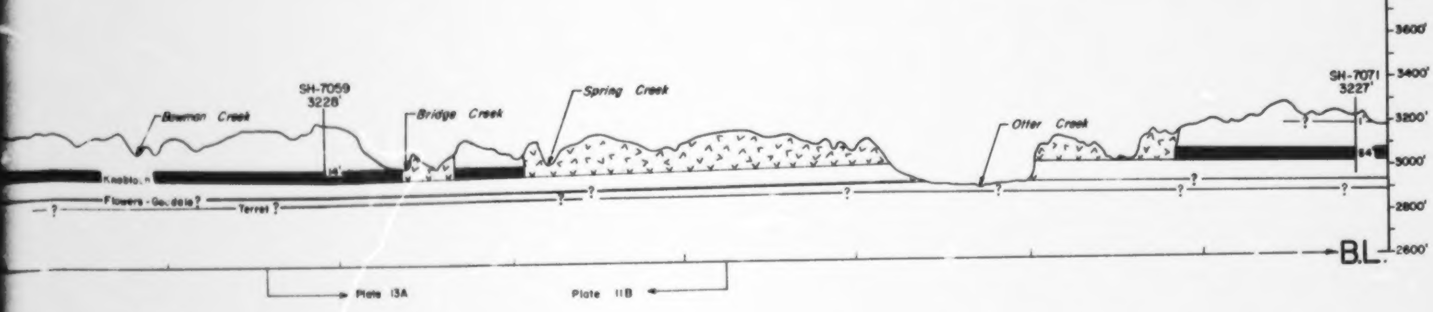

SH-7079
3225'
Beaver Creek
SH-7082
3285'
SH-7083
3350'
Liscom Creek
Cook ?
SH-708
3248'
15'
5'
11'
2'
15'
4'
12'
10'
6'
Knobloch
Flowers - Goodale
Tarret
NORTH-EAST
B.L.
Plate 29

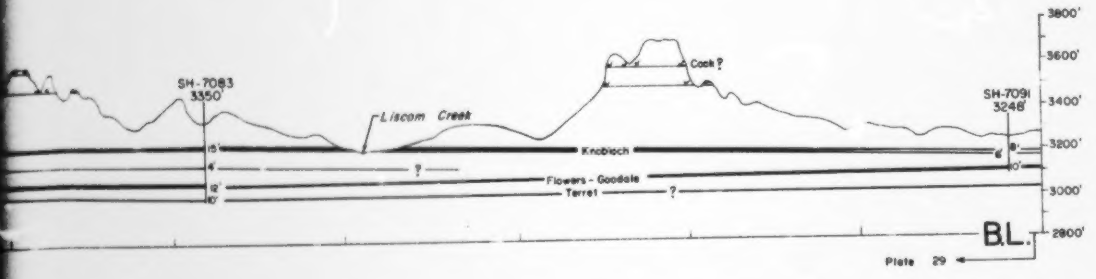

Home Creek
SH-7061
3152'
East Fork Otter Creek
SH-7068
3211'
3800'
3600'
3400'
3200'
3000'
2800'
A'.
Plate 13A

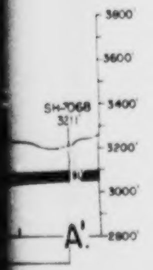

NPRR No 11
East Fork Little Pumpkin Creek
PC-31
3430'
FC-2
3282'
E
X
D ?
C ?
Sawyer
Knobloch
20'
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
P.C.
Plate 27
Plate 15
Plate 15

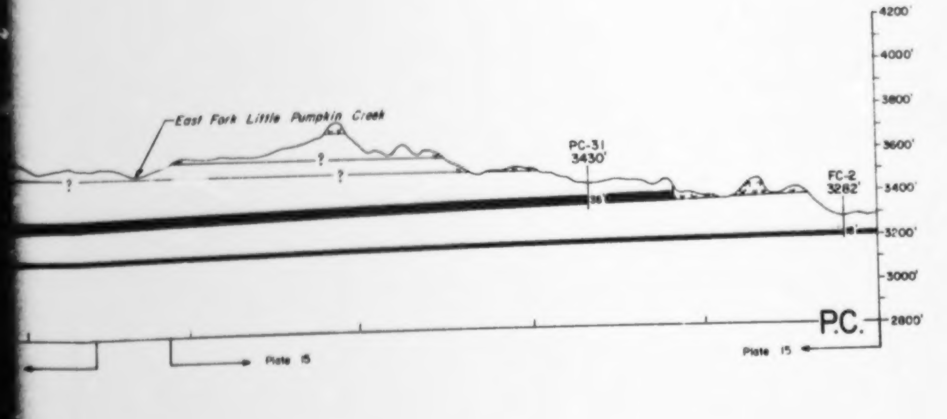

SH-7141
4053'
Canyon
NPRR No 18
NPRR No 17
Wall
Pawnee
Sawyer
US-L
3465'
17'
20'

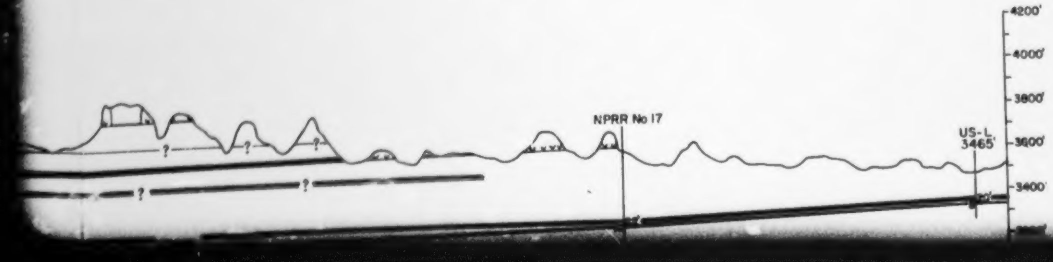
BULLETIN 91 PLATE 34

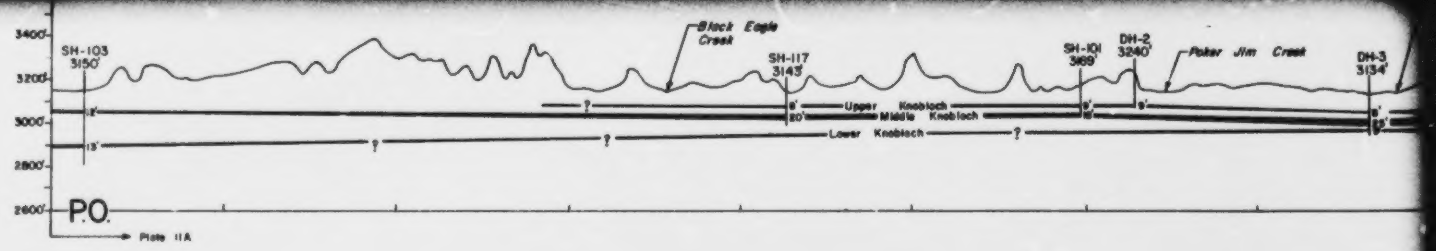

Bowman Creek
SH-7059
3228'
14'
Bridge Creek
Spring Creek
Otter Creek
SH-7071
3227'
64'
Knobloch
Flowers - Goodale ?
Terret ?
?
B.L.
3800'
3600'
3400'
3200'
3000'
2800'
2600'
Plate 13A
Plate 11B

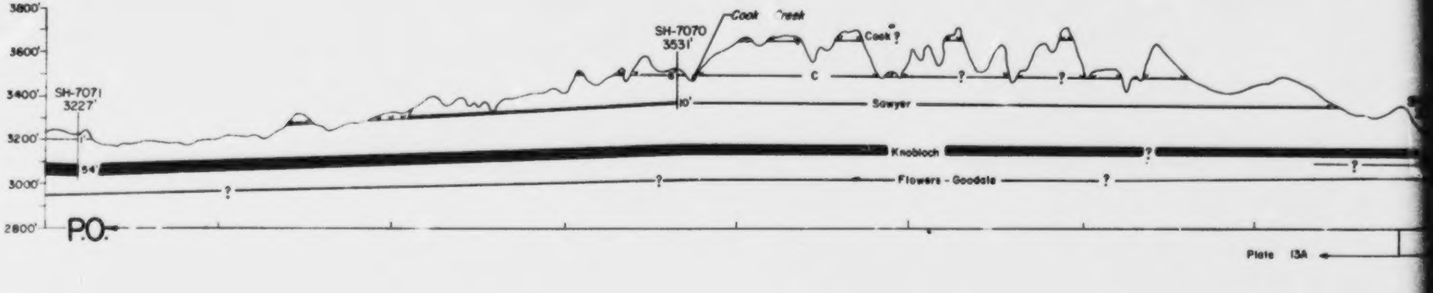

SH-7083
3350'
Liscom Creek
Cook ?
SH-7091
3248'
15'
4'
12'
10'
8'
6'
10'
Knobloch
Flowers - Goodale
Terret
?
B.L.
3800'
3600'
3400'
3200'
3000'
2800'
Plate 29

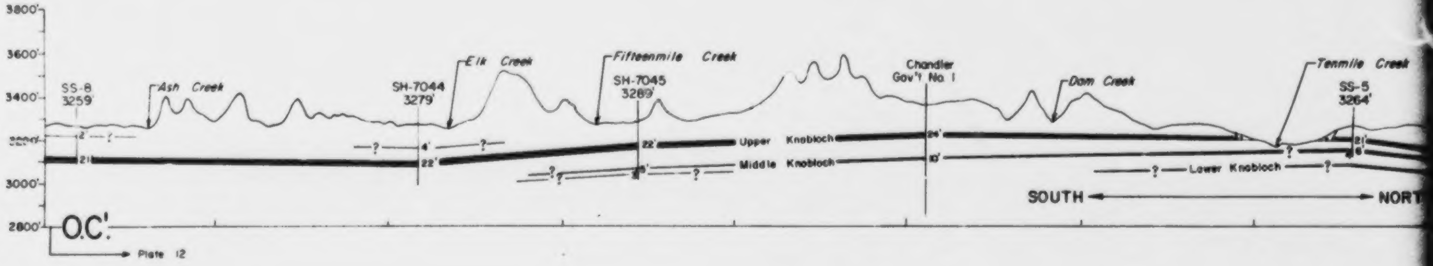

SH-7068
3211'
A'.
3800'
3600'
3400'
3200'
3000'
2800'

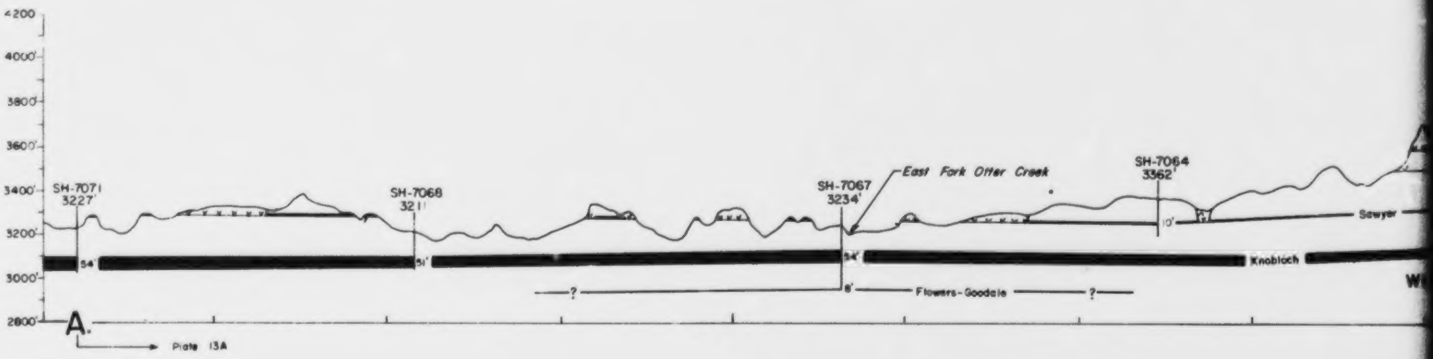

East Fork Little Pumpkin Creek
PC-31
3430'
38'
FC-2
3282'
?
P.C.
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
Plate 15
Plate 15

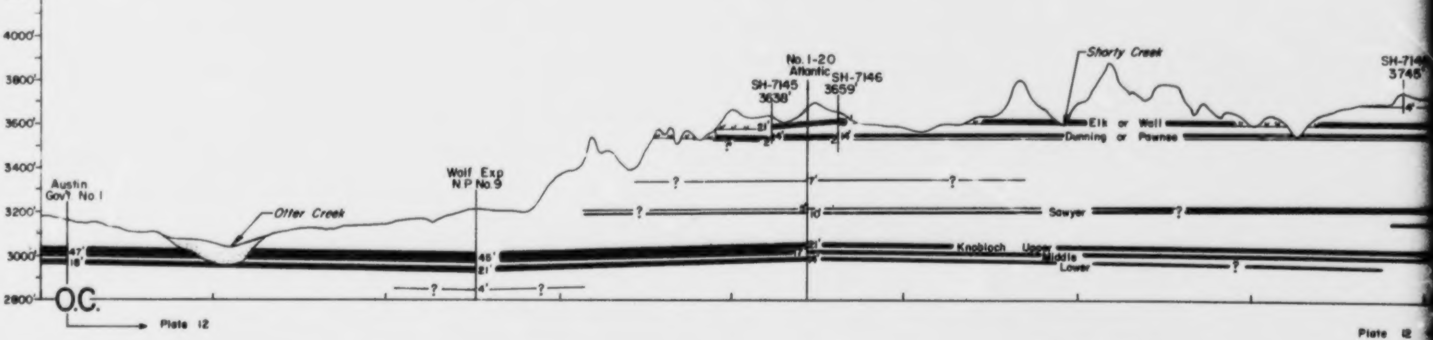

NPRR No 17
US-L.
3465'
?
4200'
4000'
3800'
3600'
3400'


3400'
3200'
3000'
2800'
2600'
SH-103
3150'
Black Eagle Creek
SH-117
3143'
SH-101
3169'
DH-2
3240'
Poker Jim Creek
DH-3
3134'
12'
13'
8'
20'
Upper Knobloch
Middle Knobloch
Lower Knobloch
?
P.O.
Plate 11A


3800'
3600'
3400'
3200'
3000'
2800'
SH-7071
3227'
SH-7070
3531'
Cook Creek
Cook ?
C
10'
Sawyer
54'
Knobloch
Flowers - Goodale
?
P.O.
Plate 13A


3800'
3600'
3400'
3200'
3000'
2800'
SS-8
3259'
Ash Creek
SH-7044
3279'
Elk Creek
Fifteenmile Creek
SH-7045
3289'
Chandler Gov't No. 1
Dam Creek
Tenmile Creek
SS-5
3264'
21'
4'
22'
24'
10'
Upper Knobloch
Middle Knobloch
Lower Knobloch
?
SOUTH
NORT
O.C'.
Plate 12

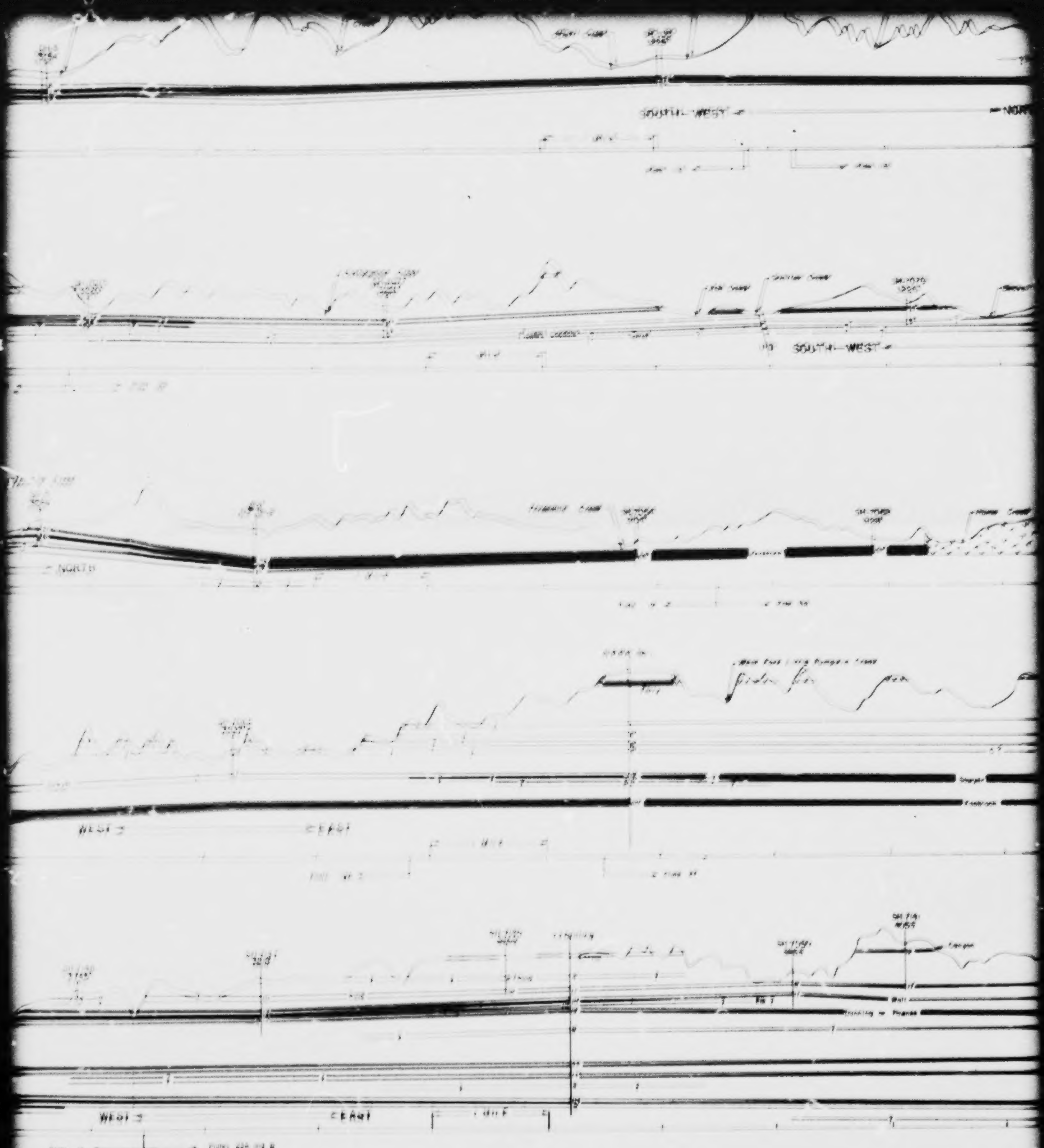

4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
SH-7071
3227'
SH-7068
3211'
SH-7067
3234'
East Fork Otter Creek
SH-7064
3362'
10'
Sawyer
54'
51'
34'
Knobloch
8'
Flowers - Goodale
?
W
A.
Plate 13A


4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
Austin Gov't No. 1
Otter Creek
Wolf Exp N P No. 9
No. 1-20 Atlantic
SH-7145
3638'
SH-7146
3659'
Shorty Creek
SH-7148
3748'
Elk or Wall
Dunning or Pawnee
Sawyer
Knobloch Upper
Middle
Lower
47'
18'
48'
21'
4'
10'
?
O.C.
Plate 12
Plate 12

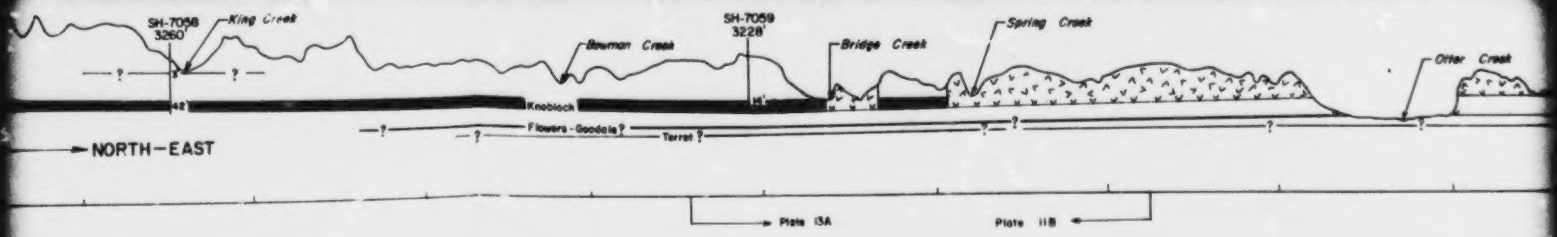
Vertical Exag. $\frac{2{,}000'}{300'} = 6\frac{2}{3}$ 300 ft.

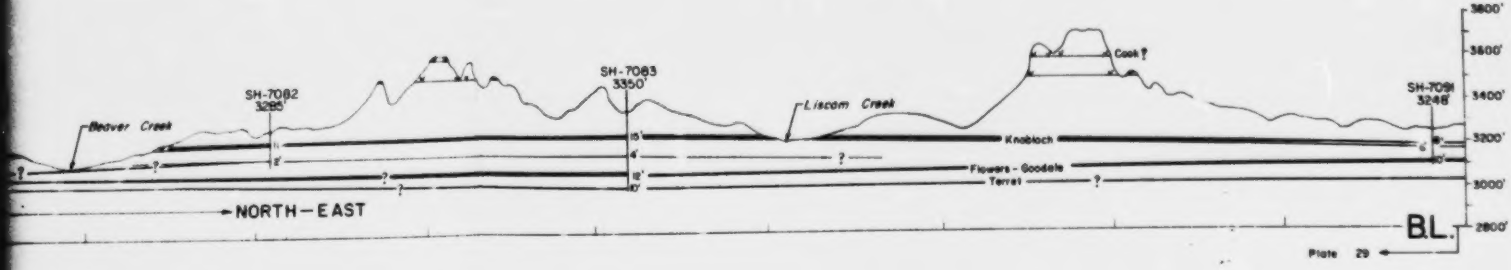
2,000 ft.

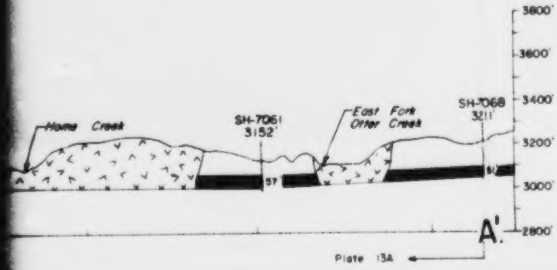
6

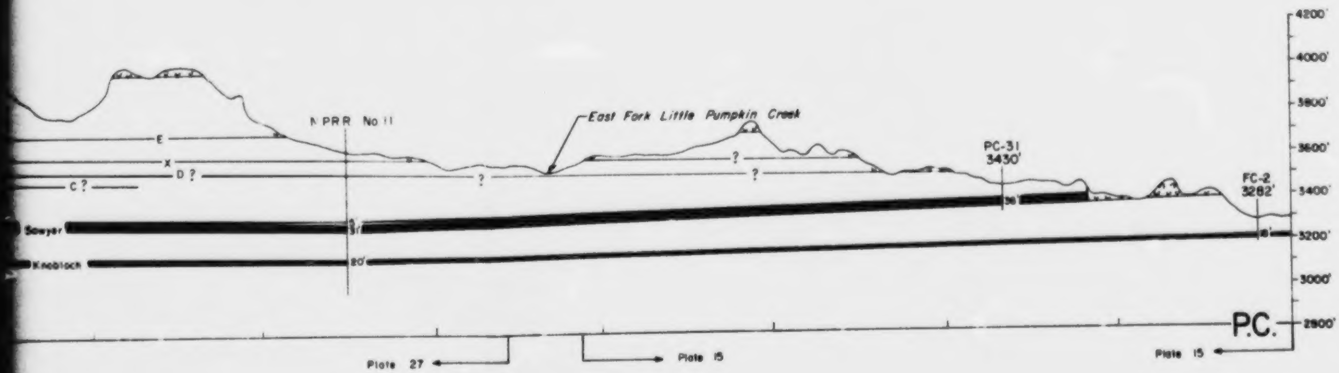

SOUTH–WEST
NORTH
SOUTH–WEST
NORTH
WEST
EAST
WEST
EAST

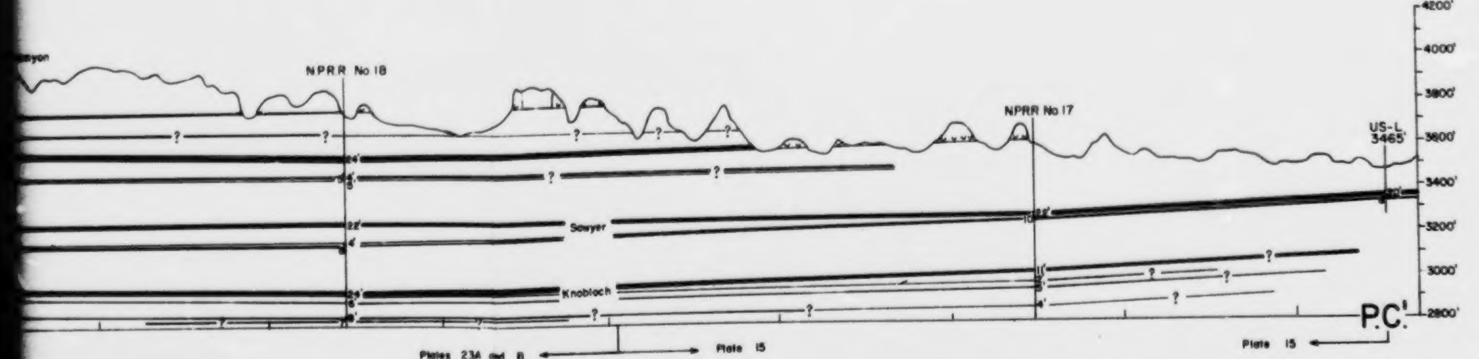
REGIONAL CROSS SECTIONS SHOWING STRUCTURE AND


SH-7058
3260'
King Creek
Bowman Creek
SH-7059
3228'
Bridge Creek
Spring Creek
Otter Creek
42'
14'
Knobloch
Flowers - Goodale ?
Terret ?
NORTH-EAST
Plate 13A
Plate 11B


Beaver Creek
SH-7082
3285'
SH-7083
3350'
Liscom Creek
Cook ?
SH-7091
3248'
15'
4'
12'
10'
Knobloch
Flowers - Goodale
Terret
NORTH-EAST
B.L.
3800'
3600'
3400'
3200'
3000'
2800'
Plate 29

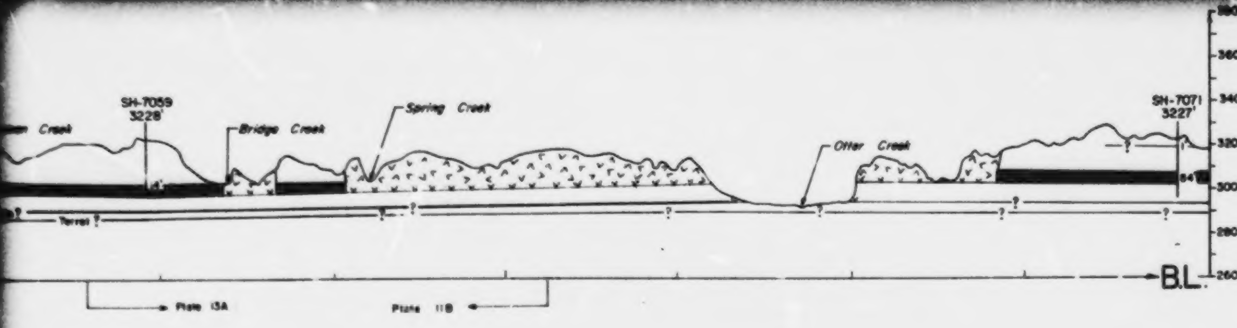

Home Creek
SH-7061
3152'
East Fork
Otter Creek
SH-7068
3211'
57
3800'
3600'
3400'
3200'
3000'
2800'
A'
Plate 13A

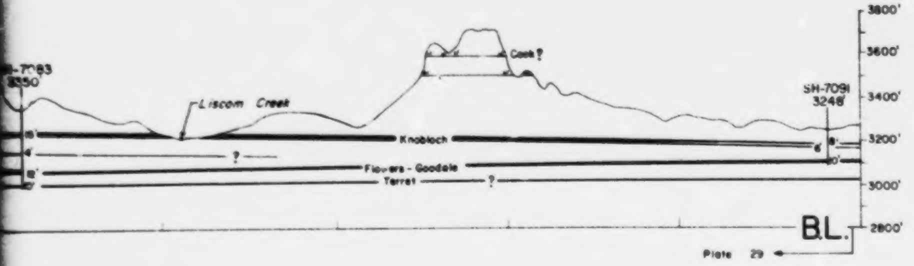

NPRR No 11
East Fork Little Pumpkin Creek
PC-31
3430'
FC-2
3282'
E
X
D ?
C ?
Sawyer
Knobloch
31'
80'
38'
18'
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
P.C.
Plate 27
Plate 15
Plate 15

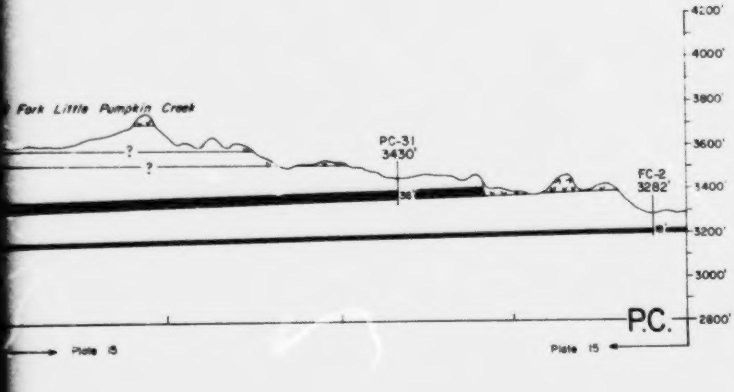

Canyon
NPRR No 18
NPRR No 17
US-L
3465'
Sawyer
Knobloch
24'
22'
4'
11'
4'
4200'
4000'
3800'
3600'
3400'
3200'
3000'
2800'
P.C'.
Plates 23A and 8
Plate 15
Plate 15

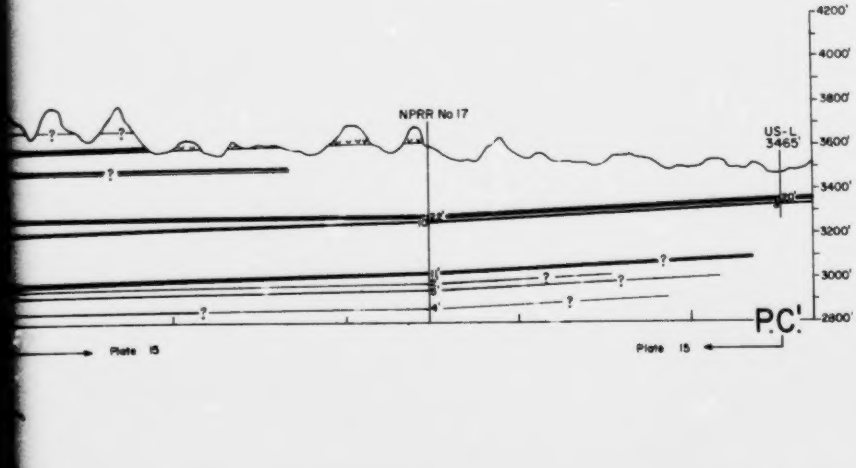
AND CORRELATION

6


Creek
SH-7059
3228'
Bridge Creek
Spring Creek
Otter Creek
SH-7071
3227'
14'
64'
Terret
?
3800'
3600'
3400'
3200'
3000'
2800'
2600'
B.L.
Plate 13A
Plate 11B


SH-7083
3350'
Liscom Creek
Cook ?
SH-7091
3248'
Knobloch
Flowers - Goodale
Terret
?
6'
8'
10'
3800'
3600'
3400'
3200'
3000'
2800'
B.L.
Plate 29


Fork Little Pumpkin Creek
PC-31
FC-2
?
P.C.
Plate 15
Plate 15

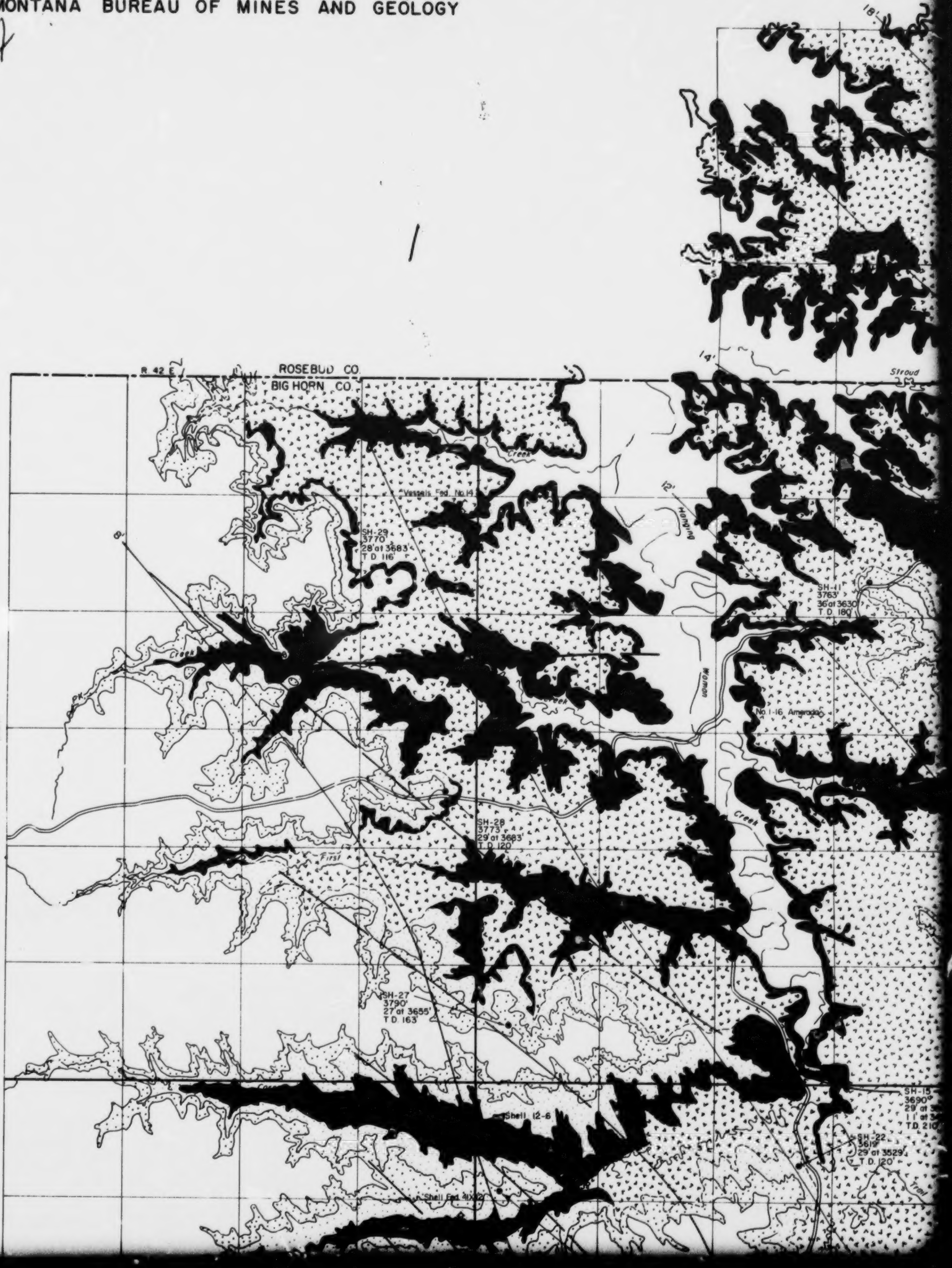

NPRR No 17
US-L
?
P.C'.
Plate 15
Plate 15

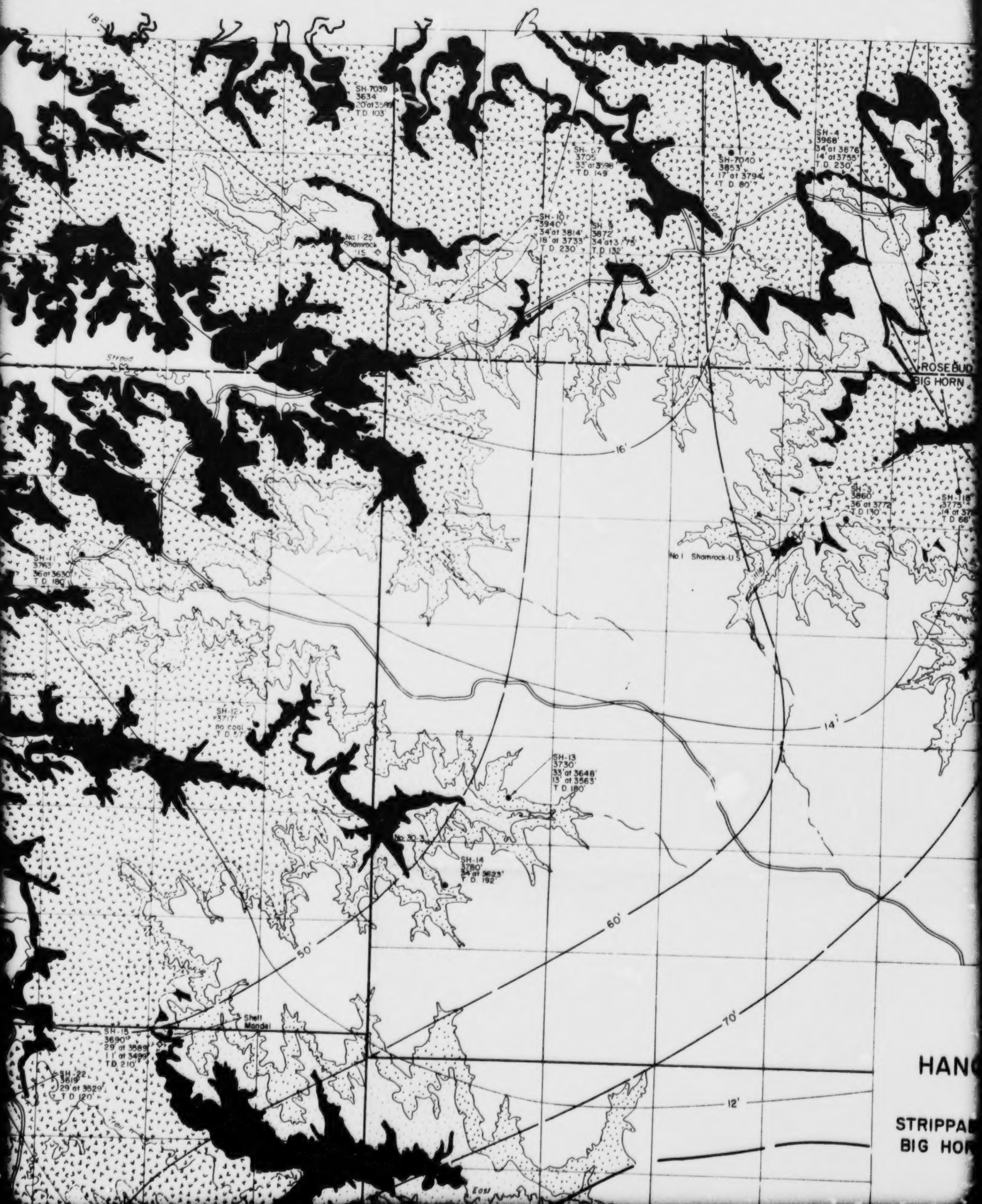
H

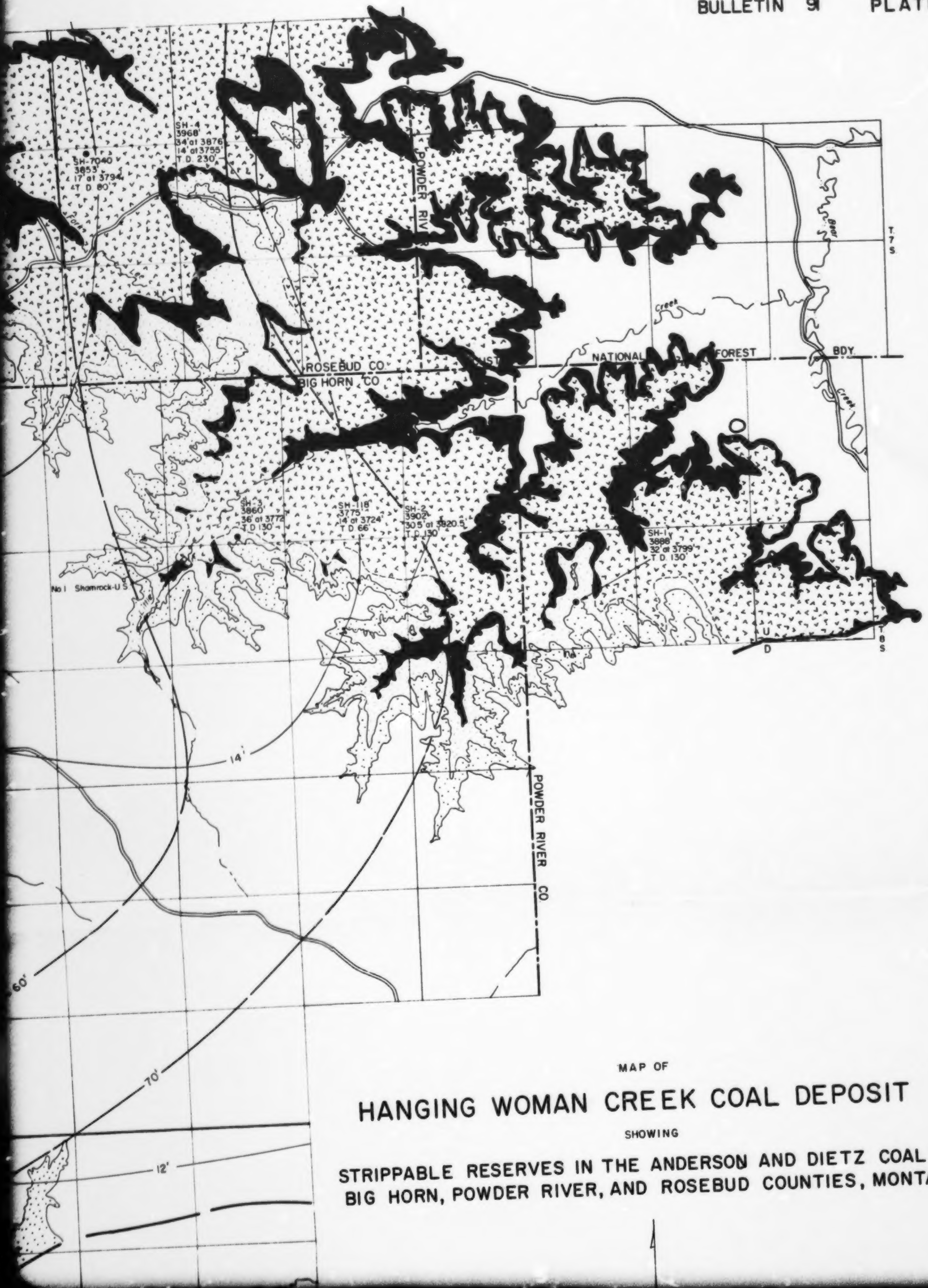
MONTANA BUREAU OF MINES AND GEOLOGY

A

1


18'
R 42 E
ROSEBUD CO.
BIG HORN CO.
Creek
Vessels Fed. No 14
SH-29
3770'
28' at 3683'
T.D. 116'
12'
Hanging Woman
14'
Stroud
SH-11
3763'
36' at 3630'
T.D. 180'
No 1-16 Amerada
T 8 S
Creek
Creek
First
SH-28
3773'
29' at 3683'
T.D. 120'
SH-27
3790'
27' at 3655'
T.D. 163'
Shell 12-6
Shell Fed. 41X-12
SH-15
3690'
29' at 3
11' at 3
T.D. 210
SH-22
3619'
29' at 3529'
T.D. 120'
Trail


18'
SH-7039
3634'
20' at 3599'
T.D. 103'
SH-57
3705'
33' at 3598'
T.D. 149'
SH-7040
3853'
17' at 3794'
T.D. 80'
SH-4
3968'
34' at 3876'
14' at 3755'
T.D. 230'
SH-10
3940'
34' at 3814'
18' at 3733'
T.D. 230'
SH-5
3872'
34' at 3775'
T.D. 132'
No. 1-25
Shamrock
15
Fork
Stroud
ROSEBUD
BIG HORN
16'
SH-3
3860'
36' at 3772'
T.D. 130'
SH-11
3775'
14' at 37
T.D. 66'
No. 1 Shamrock-U.S.
Little
SH-11
3763'
36' at 3630'
T.D. 180'
14'
SH-12
3717'
no coal
T.D. 57'
SH-13
3730'
33' at 3648'
13' at 3563'
T.D. 180'
No. 30-3
SH-14
3780'
34' at 3623'
T.D. 192'
50'
60'
70'
Shell
Mandel
SH-15
3690'
29' at 3589'
11' at 3499'
T.D. 210'
SH-22
3619'
29' at 3529'
T.D. 120'
Trail
12'
East
HANG
STRIPPAB
BIG HOR

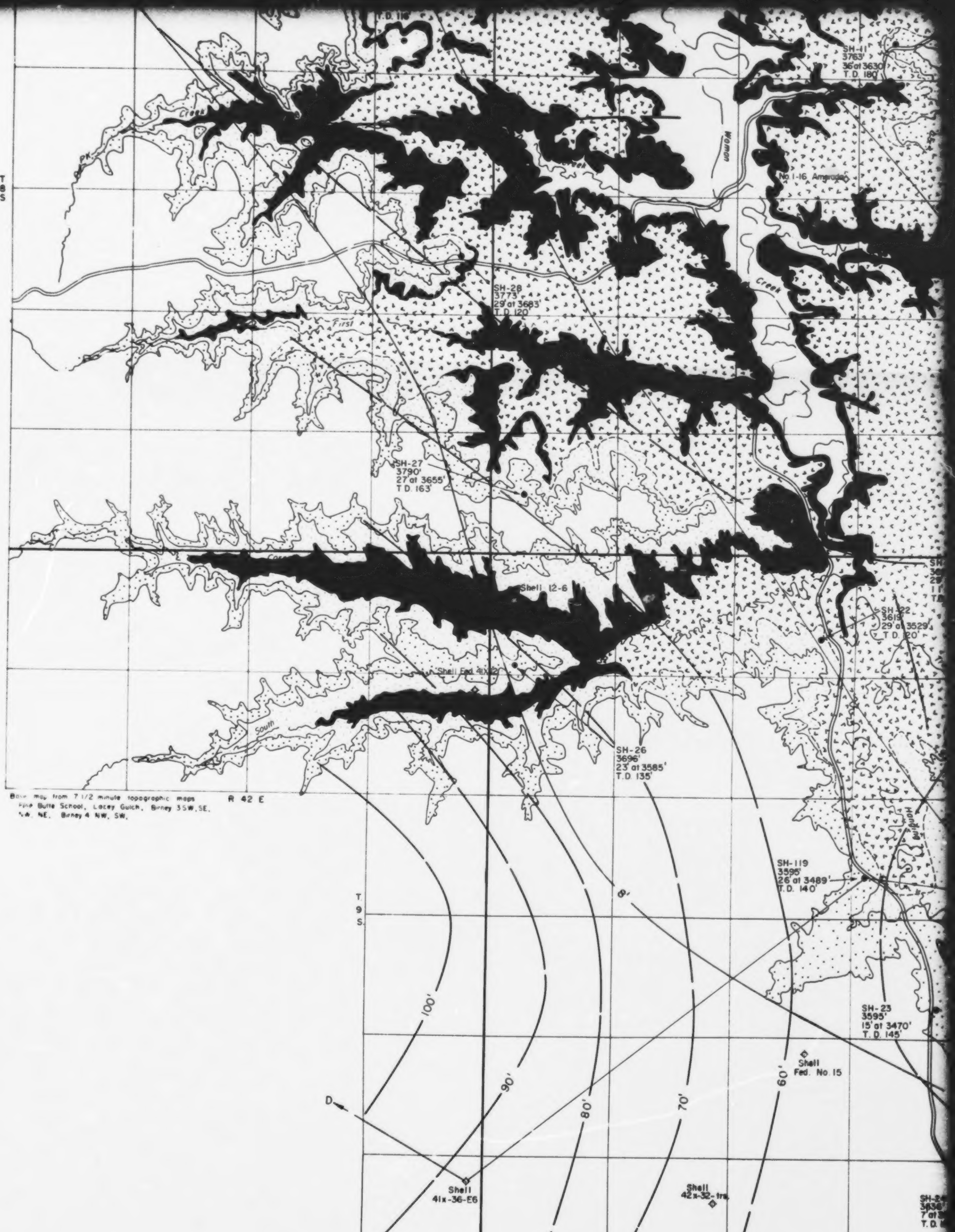

SH-4
3968
34' at 3876
14' at 3755'
T.D. 230
SH-7040
3853
17' at 3794
T.D. 80
Forks
POWDER RIV
Creek
Boot
T. 7 S.
CUST
NATIONAL FOREST BDY
ROSEBUD CO
BIG HORN CO
Creek
SH-2
3860
36' at 3772
T.D. 130
SH-11B
3775
14' at 3724
T.D. 66
SH-2
3902
30.5' at 3820.5
T.D. 130
SH-1
3888
32' at 3799
T.D. 130
No. 1 Shamrock-U.S.
U
D
T. 8 S.
14'
POWDER RIVER CO
60'
70'
12'

MAP OF

HANGING WOMAN CREEK COAL DEPOSIT

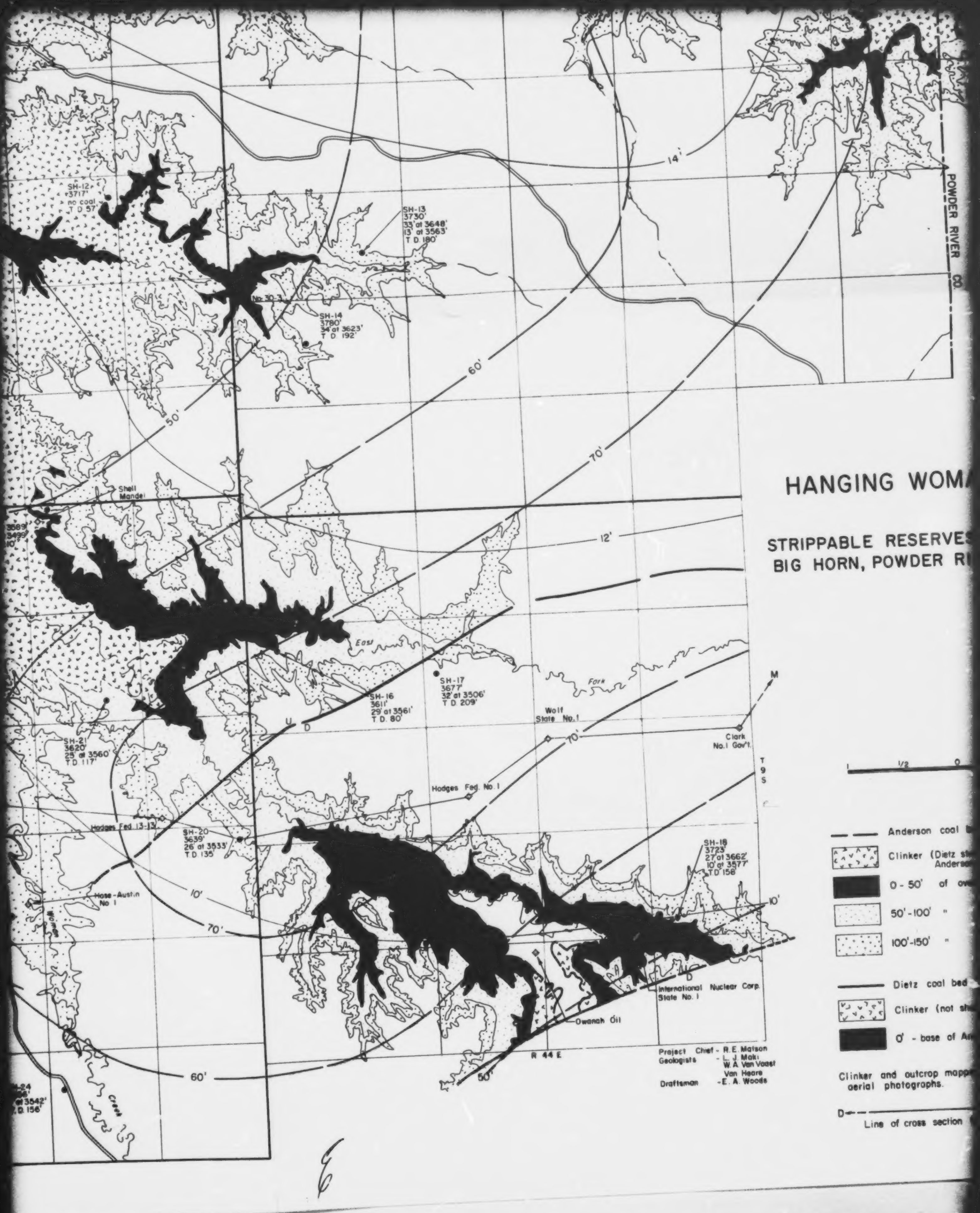
SHOWING

STRIPPABLE RESERVES IN THE ANDERSON AND DIETZ COAL BEDS, BIG HORN, POWDER RIVER, AND ROSEBUD COUNTIES, MONTANA

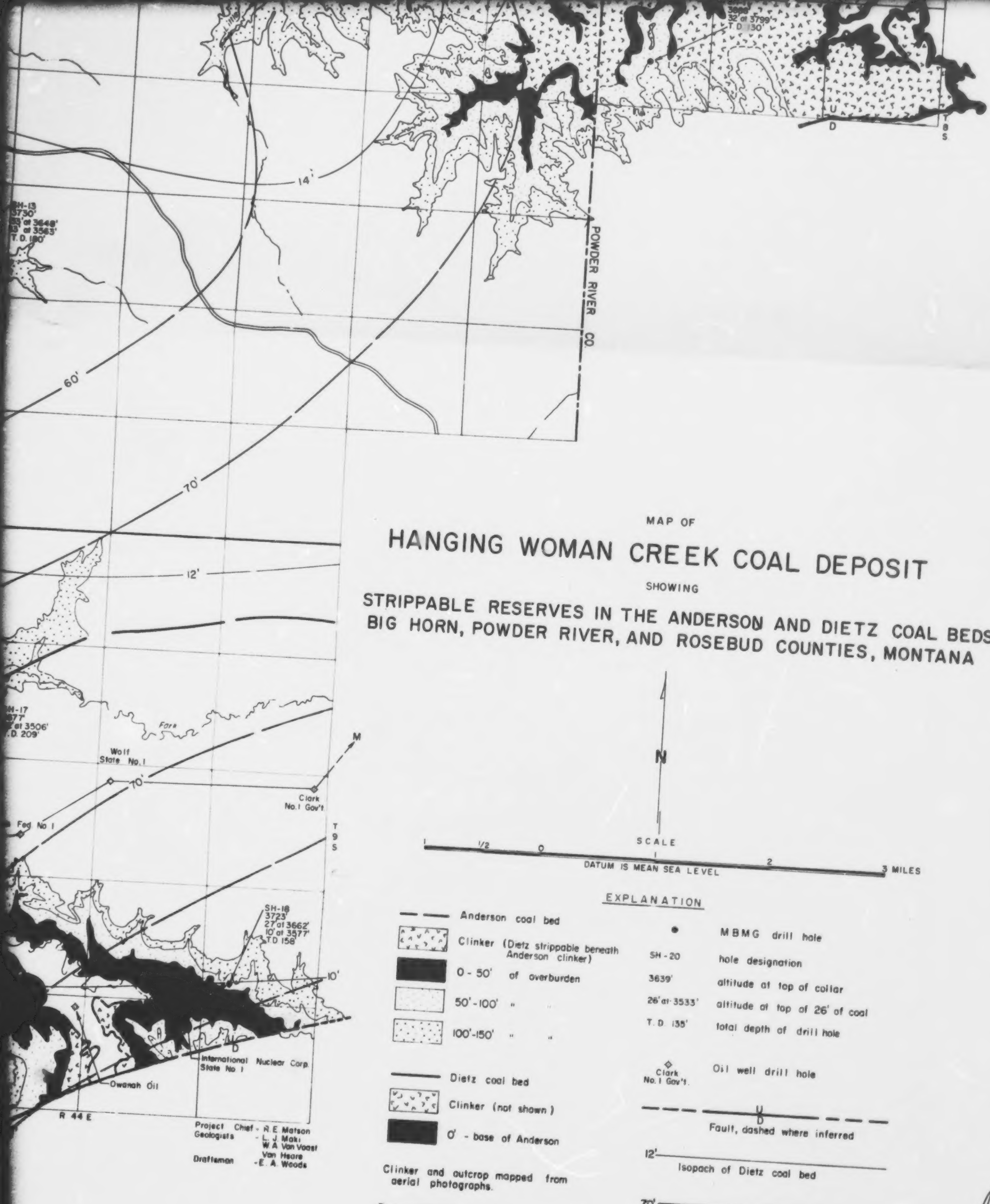

T.D. 116'
SH-11
3763'
36' at 3630'
T.D. 180'
Creek
Woman
Creek
No. 1-16 Amerada
T 8 S
SH-28
3773'
29' at 3683'
T.D. 120'
Creek
First
SH-27
3790'
27' at 3655'
T.D. 163'
Creek
Shell 12-6
SH-22
3619'
29' at 3529'
T.D. 120'
Shell Fed. 41X-12
South
SH-26
3696'
23' at 3585'
T.D. 135'
R 42 E
T
9
S.
SH-119
3595'
26' at 3489'
T.D. 140'
100'
90'
80'
70'
60'
SH-23
3595'
15' at 3470'
T.D. 145'
Shell
Fed. No. 15
D
Shell
41x-36-E6
Shell
42x-32-frs.
R. 43 E.

Base map from 7 1/2 minute topographic maps
Pine Butte School, Lacey Gulch, Birney 3 SW, SE,
NW, NE, Birney 4 NW, SW,

D


HANGING WOMA
STRIPPABLE RESERVES
BIG HORN, POWDER RI
POWDER RIVER CO.
SH-12
3717'
no coal
T.D. 57'
SH-13
3730'
33' at 3648'
13' at 3563'
T.D. 180'
No. 30-3
SH-14
3780'
34' at 3623'
T.D. 192'
14'
60'
50'
70'
12'
Shell
Mandel
3589'
3499'
10'
East
Fork
SH-17
3677'
32' at 3506'
T.D. 209'
SH-16
3611'
29' at 3561'
T.D. 80'
U
D
Wolf
State No. 1
Clark
No. 1 Gov't.
M
SH-21
3620'
25' at 3560'
T.D. 117'
T
9
S
Hodges Fed. No. 1
Hodges Fed. 13-13
SH-20
3639'
26' at 3533'
T.D. 135'
SH-18
3723'
27' at 3662'
10' at 3577'
T.D. 158'
Hose-Austin
No. 1
10'
70'
10'
International Nuclear Corp.
State No. 1
D
A
Owanah Oil
R 44 E
60'
50'
SH-24
at 3542'
T.D. 156'
Creek
1
1/2
0
Anderson coal b
Clinker (Dietz st
Anderso
0 - 50' of ov
50'-100' "
100'-150' "
Dietz coal bed
Clinker (not sh
0' - base of An
Clinker and outcrop mapp
aerial photographs.
D
Line of cross section
Project Chief - R. E. Matson
Geologists - L. J. Maki
W. A. Van Voast
Van Heare
Draftsman - E. A. Woods

6


POWDER RIVER CO.
14'
60'
70'
12'
10'
SH-13
3730'
at 3648'
at 3563'
T.D. 180'
SH-17
3577'
at 3506'
T.D. 209'
Fork
Wolf
State No. 1
Clark
No. 1 Gov't
Fed No 1
M
D
U
T
9
S
8
S
SH-18
3723'
27' at 3662'
10' at 3577'
T.D 158
3690
32' at 3799'
T.D. 130'
International Nuclear Corp.
State No 1
Owanah Oil
R 44 E

Project Chief - R. E. Matson
Geologists - L. J. Maki
W. A. Van Voast
Van Hoare
Draftsman - E. A. Woods

MAP OF

HANGING WOMAN CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE ANDERSON AND DIETZ COAL BEDS, BIG HORN, POWDER RIVER, AND ROSEBUD COUNTIES, MONTANA

N

SCALE

1 1/2 0 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

— — Anderson coal bed

▨ Clinker (Dietz strippable beneath Anderson clinker)

■ 0 - 50' of overburden

□ 50'-100' " "

▨ 100'-150' " "

—— Dietz coal bed

▨ Clinker (not shown)

■ 0' - base of Anderson

Clinker and outcrop mapped from aerial photographs.

D← — — — — →M Line of cross section (plate 33)

●	MBMG drill hole
SH - 20	hole designation
3639'	altitude at top of collar
26' at 3533'	altitude at top of 26' of coal
T. D. 135'	total depth of drill hole
◇ Clark No. 1 Gov't.	Oil well drill hole

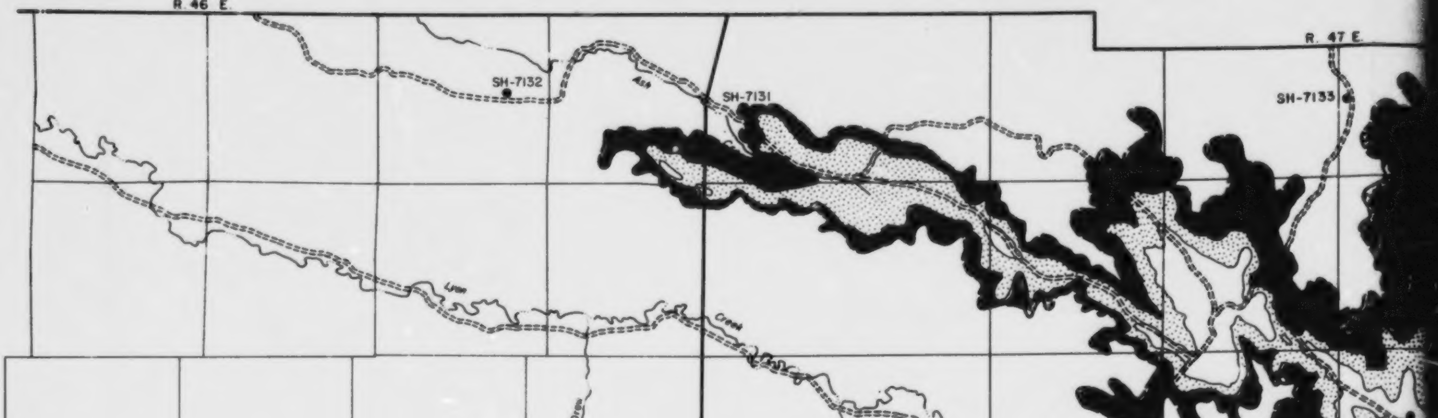
— — —U/D— — — Fault, dashed where inferred

12' —— Isopach of Dietz coal bed

70' —— —— Isopach of interburden between Anderson & Dietz coal beds.

A

MONTANA BUREAU OF MINES AND GEOLOGY


R. 46 E.
R. 47 E.
SH-7132
Ash
SH-7131
SH-7133
Lyon
Creek
Goodspeed
Draw
Pass
Draw
T. 6 S.
10'
SH-7126
SH-7125
3960'
8' at 3906'
15' at 3686'
T.D. 300'
SH-7124
3934'
8' at 3879'
14' at 3678'
12' at 3630'
T.D. 400'
SH-7123
4052'
4' at 3880'
15' at 3861'
T.D. 240'
SH-7130
4118'
4' at 4045'
7' at 3978'
T.D. 180'
Vin White #1
SH-7129
3976'
11' at 3903'
T.D. 100'
Chandler #1
North
Fork
15'
R. 46 E.
R. 47 E.

MAP OF

DIAMOND BUTTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE CANYON COAL BED, POWDER RIVER COUNTY, MONTANA

SCALE.

0 1/2 1 2 3 Miles

DATUM IS MEAN SEA LEVEL

N

EXPLANATION

— — Canyon coal bed
▨ Clinker
■ 0-50' of overburden
░ 50'-100' " "
░ 100'-150' " "

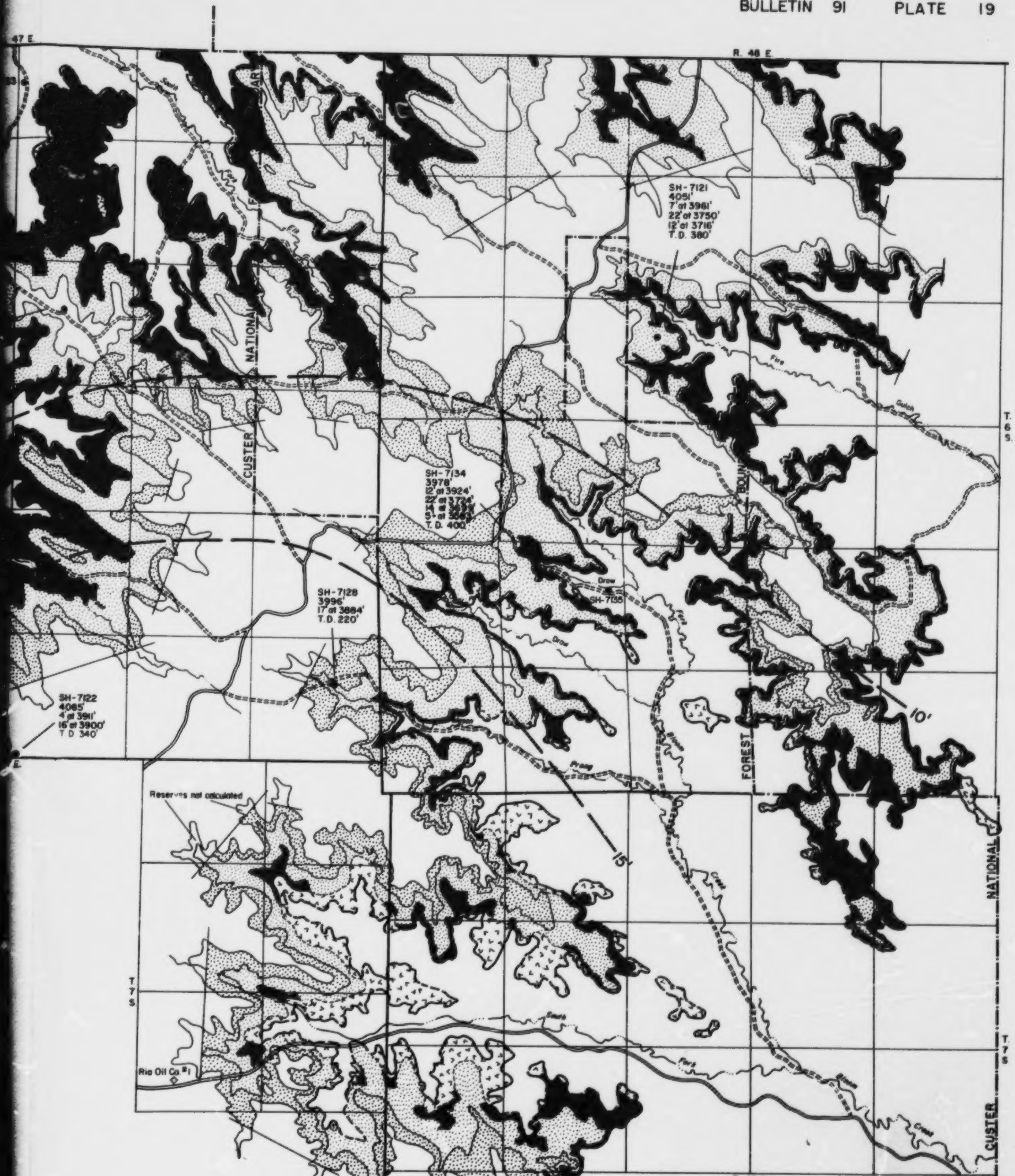
● M.B.M.G. drill hole
SH-7129 hole designation
3976' altitude at top of collar
11' at 3903' altitude at top of 11' of coal
T.D. 100' total depth of drill hole
◇ Rio Oil Co. #1 Oil well drill hole

—10'— Isopach of Canyon coal bed.

Clinker and outcrop mapped by J.W. Blumer, from colored aerial photographs

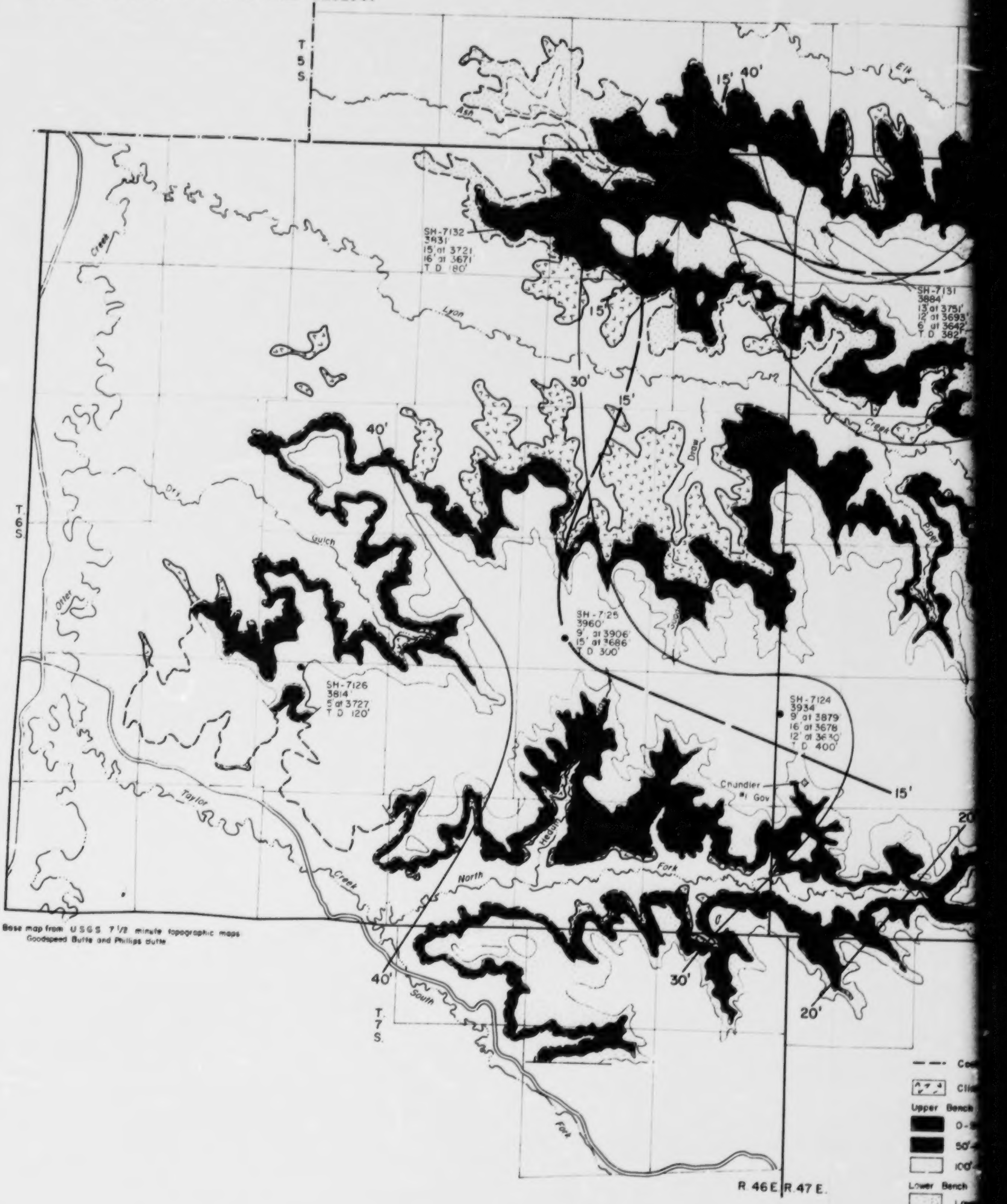
Base map from U.S.G.S. 7 1/2 minute topographic map: Phillips Butte, Hedsdon Flats

B


47 E.
R. 48 E.
CUSTER
NATIONAL
FOREST
BOUN
SH-7121
4051'
7' at 3981'
22' at 3750'
12' at 3716'
T. D. 380'
Fire
Gulch
T. 6 S.
SH-7134
3978'
12' at 3924'
22' at 3724'
T. D. 400'
SH-7128
3996'
17' at 3884'
T. D. 220'
SH-7135
Drow
SH-7122
4085'
4' at 3911'
16' at 3900'
T. D. 340'
10'
15'
Prong
Reserves not calculated
Creek
T. 7 S.
Rio Oil Co. #1
South
Fork
Creek
R. 48 E.
Project Chief – R. E.
Geologist – J. W.
Draftsman – M. J.

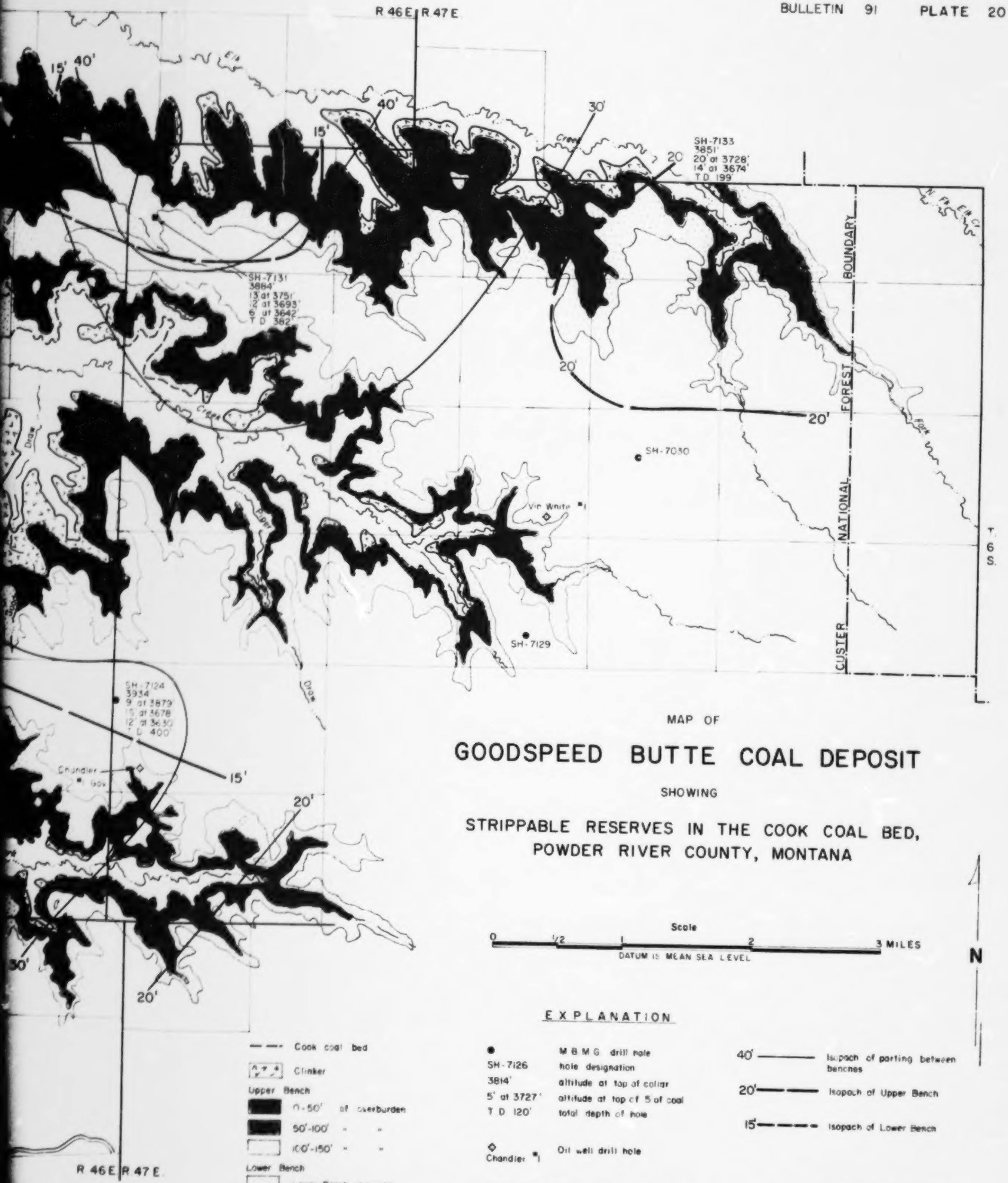
A

MONTANA BUREAU OF MINES AND GEOLOGY


T. 5 S.
T. 6 S.
T. 7 S.
R. 46 E. R. 47 E.
Ash
Elk
Creek
Lyon
Dry
Gulch
Otter
Taylor
Creek
North
Fork
South
Fork
Draw
Hedlin
Creek
SH-7132
3831'
15' at 3721'
16' at 3671'
T.D. 180'
SH-7131
3884'
13' at 3751'
12' at 3693'
6' at 3642'
T.D. 382'
SH-7125
3960'
9' at 3906'
15' at 3686'
T.D. 300'
SH-7126
3814'
5' at 3727'
T.D. 120'
SH-7124
3934
9' at 3879
16' at 3678
12' at 3630'
T.D. 400'
Chandler
#1 Gov
15'
40'
30'
20'
Coa
Cli
Upper Bench
0-
50'-
100'-
Lower Bench
Lo
Upp

Base map from U.S.G.S. 7½ minute topographic maps
Goodspeed Butte and Phillips Butte

B


R 46 E | R 47 E
15'
40'
40'
15'
30'
20
Elk
Creek
SH-7133
3851'
20' at 3728'
14' at 3674'
T D 199'
N. Fk. Elk Cr.
BOUNDARY
FOREST
NATIONAL
CUSTER
SH-7131
3884'
13' at 3751'
12' at 3693'
6' at 3642'
T D 382'
20'
20'
Creek
Fork
SH-7080
Draw
Piper
Vin White 1
T. 6 S.
SH-7129
Draw
SH-7124
3934
9' at 3879'
15' at 3678'
12' at 3630'
T D 400'
Chandler 1 Gov.
15'
20'
30'
20'
R 46 E | R 47 E

MAP OF

GOODSPEED BUTTE COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE COOK COAL BED, POWDER RIVER COUNTY, MONTANA

Scale

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

N

EXPLANATION

— — Cook coal bed

▨ Clinker

Upper Bench

■ 0-50' of overburden

■ 50'-100' " "

☐ 100'-150' " "

Lower Bench

☐ Lower Bench strippable, Upper Bench absent

●	M B M G drill hole
SH-7126	hole designation
3814'	altitude at top of collar
5' at 3727'	altitude at top of 5 of coal
T D 120'	total depth of hole
◇ Chandler 1	Oil well drill hole

40' ——— Isopach of parting between benches

20' — — Isopach of Upper Bench

15' - - - - Isopach of Lower Bench

Clinker and outcrop mapped by J. W. Blumer from aerial photographs

Project Chief - R E Matson
Geologist - J W Blumer
Draftsman - E A Woods